Feasibility Study for the Lake Victoria Basin Integrated Water Resources Management Programme with High Priority Investments
(BMZ-No. 2013 67 309)

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Feasibility Study
High Priority Investment
Kisumu Informal Settlements Sanitation

Final

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Client:
Lake Victoria Basin Commission

JUMUIYA YA AFRIKA MASHARIKI

Consultant
JV SWECO – Alterra – Ecorys

SWECO ALTERRA WAGENINGEN UR ECORYS

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Authors	:	Jan Spit, Simon Muthira and Nathan Mwema (Runji & Partners), Peter Vos (Ecorys) and Isabel Munandi (Runji & Partners)
E-mail	:	adsannen.id.as@gmail.com
Checked by	:	Ad Sannen
Signature checked	:	
Approved by	:	Alexander von Goertz
Signature approved	:	
Contact	:	Sweco GmbH Hanauer Landstraße 135-137 60314 Frankfurt am Main Phone +49 69 95921 0 www.sweco-gmbh.de

Table of contents

List of Figures

List of Tables

Glossary

ABR	Anaerobic Baffle Reactor
AFD	Agence Française de Développement
BOD	Biological Oxygen Demand
CBO	Community Based Organisation
COD	Chemical Oxygen Demand
CW	Constructed Wetland
DMM	Delegated Management Model
EAC	East African Community
EDF	European Development Fund
EIA	Environmental Impact Assessment
EIB	European Investment Bank
EU	European Union
FCR	Full-Cost Recovery Ratio
FLO	Fresh Life Operators
FLT	Fresh Life Toilets
FS	Feasibility Study
FY	Financial Year
GIS	Geographical Information System
HPI	High Priority Investments
HRT	Hydraulic Retention Time
IFI	International Financing Institutions
hh	households
IWRM	Integrated Water Resources Management
KFW	German Development Bank
KISS	Kisumu Informal Settlements Sanitation
KM	Knowledge Management
KNBS	Kenya National Bureau of Statistics
KES	Kenyan Shilling
LTAP	Long Term Action Plan
LVBC	Lake Victoria Basin Commission
LVEMP	Lake Victoria Environmental Management Programme
LVEMP-II	Lake Victoria Environmental Management Programme - Phase II
LVSWSB	Lake Victoria South Water Services Board
LVWATSAN-II	Lake Victoria Water and Sanitation Programme - Phase II
MD	Mechanical Dewatering
MDGs	Millennium Development Goals
mln	Million
MO	Master Operator
MOU	Memorandum of Understanding
MWI	Ministry of Water and Irrigation
NFP(O)	National Focal Point (Officers)
NGO	Non-Governmental Organization
NRW	Non Revenue Water
NWSS	National Water Services Strategy
O&M	Operation and Maintenance
PIA	Project Implementation Agency
PIU	Project Implementation Unit
RPSC	Regional Policy Steering Committee
SEA	Strategic Environmental Assessment

ST	Sludge Thickener
SWOT	Strength Weakness Opportunity & Threats Analysis
TA	Technical Assistance
TOR	Terms Of Reference
TS	Total Solids
TSS	Total Suspended Solids
TWG	Technical Working Group
VFCW	Vertical Flow Constructed Wetlands
VS	Volatile Solids
VSS	Volatile Suspended Solids
WASREB	Water Services Regulatory Board
WATSAN	Water and Sanitation
WIM	Water Intervention Module
WP	Working Package (1, 2 and 3)
WRM	Water Resources Module
WRMIS	Water resources Monitoring Information System
WSB	Water Service Board
WSP	Water Service Provider
WSTF	Water Services Trust Fund
WTD	Wastewater Treatment Districts
WUM	Water Utilization Module

Executive Summary

The Lake Victoria Basin Commission (LVBC) is intensifying its efforts on Integrated Water Resources Management (IWRM), in concordance with the sustainable development agenda of the East African Community (EAC). In membership countries planning, design and construction of water supply systems, wastewater treatment facilities and solid waste management do not keep up with population growth. Lack of sanitation facilities, open defecation and poor faecal sludge management lead to eutrophication and microbiological pollution of Lake Victoria.

For the medium-long term, LVBC intends to develop IWRM for the basin using a step-by-step approach, with a focus on the short term, on the pressing and 'no-regret' issue of wastewater and sanitation. SWECO and partners were selected to execute the *'Feasibility Study for the Lake Victoria Basin Integrated Water Resources Management Programme With High Priority Investments (BMZ-No. 2013 67 309)'* as a part of Work Package 2.

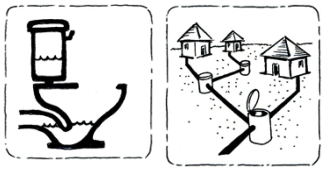
Four High Priority Investment (HPI) projects were selected in four countries, based on a selection process guided by LVBC in close consultations with the stakeholders. The following HPIs were selected:

1. Wastewater treatment and sewerage in Mwanza, Tanzania
2. Constructed Wetlands in Kampala, Uganda
3. Faecal sludge treatment in Kigali, Rwanda
4. Rehabilitation of the sewerage treatment network in Kisumu, Kenya

For each of these HPIs a feasibility study has been prepared.

The stakeholders endorsed the selection of the HPIs for further feasibility review during the inception meeting of the 3rd of March 2016 in Kisumu.

For Kisumu, the selected project area has changed after discussions with Lake Victoria South Water Services Board (LVSWSB) and the EIB/ AfD and now covers sanitation in informal settlements in Kisumu. The sanitation system is based on the principle of condominium sewerage.



Condominium sewerage also indicated as Shallow Sewers or Simplified Sewers, describe a sewerage network that is constructed using smaller diameter pipes laid at a shallower depth and at a flatter gradient than conventional sewers. The condominium sewerage allows for a more flexible design associated with lower costs and a higher number of connected households (hh). See Figure 1.

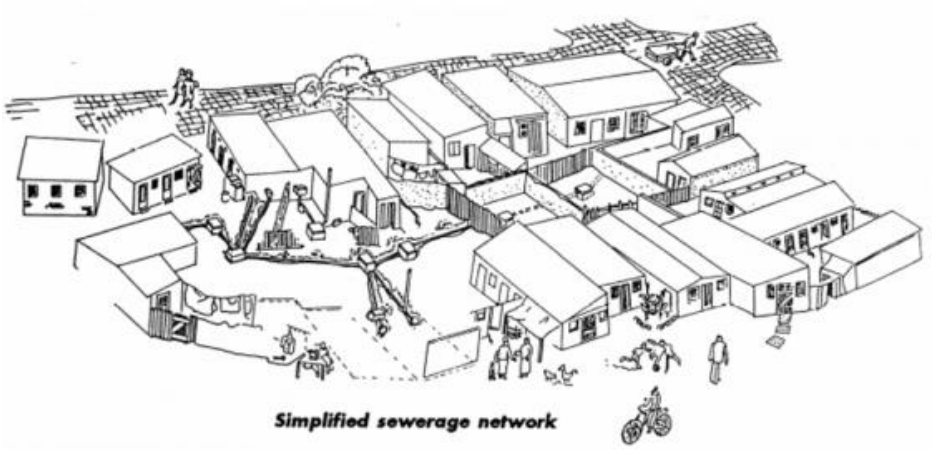


Figure 1: Shallow Sewerage (SSWM, 2012)

Investment costs

The investment is composed of:

- Construct 18 km sewer line in Manyatta A, 20 km sewer line in Manyatta B and 13 km sewer line in Obunga settlement. Topographic and geotechnical surveys need to be undertaken for the sewer lines;
- Construct 690 ablution blocks in Obunga settlement;
- The following areas can be connected by gravity: 11,300 households in Manyatta A, 7,000 hh in Manyatta B, and 6,900 hh in Obunga. Total 25,200 hh;
- Total costs: € 14.4 mln. for improved sanitation;
- Augmentation piped water supply: € 1.66 mln;
- Total costs: € 16 mln. See
- Table 1.

Table 1: Summary costs

No	Description	Amount (rounded) Million €
1	Total Direct Investment: Sewer line and ablution blocks	12.86
2	Capacity building	0.13
3	Construction supervision	1.29
4	Project Management Unit	0.13
5	Total sanitation improvement	14.41
6	Augmentation of piped water supply	1.66
7	*Grand total*	16.07
8	***Grand total (rounded)***	**16.00**

Financial Analysis

Figure 2 presents the year-on-year cash flow of the project under operations (before financing).

Figure 2: Cumulative and Year-on-year Cash Flow of Operations

Even with an income of KES 30,000 per month (approximately 275 €, which is relative high) and a sponsored tariff, the project is not affordable. Cost recovery of operation and maintenance (O&M) is not possible; let alone Full Cost Recovery.

Recommendation: the project needs a step-by-step incremental implementation whereby only households that can afford the system participate.

Table 2 presents the conclusions and recommendations of the Feasibility Study on Kisumu informal settlement sanitation.

Table 2: Conclusions and Recommendations

Conclusions	**Recommendations**
The sanitary conditions in the informal settlements in Kisumu are very poor: there are insufficient facilities and the facilities are inadequate.	Immediate action to improve the sanitary conditions.
Kisumu does not have a master plan for sewerage and sanitation with existing sewage flows and future needs. The successes of condominium sewers depend on the overall system.	The preparation of a Wastewater and sanitation Master Plan need to be a pre-requisite for any condominium sewerage project.
KIWASCO has many challenges in operating and maintaining sewerage and wastewater treatment. The success of condominium sewers depends on proper O&M of the general system.	Improved O&M by KIWASCO of the overall sewerage is a pre-requisite for any condominium sewerage project. MOs need to be trained and equipped adequately.
The condominium sewerage as proposed by LVSWSB based on the Delegated Management Model (DMM) is a new idea with no other case study to learn from.	Implement the condominium sewerage on a pilot base and pilot also non-sewered sanitation service models.
The condominium sewerage as proposed by LVSWSB was to be connected to a decentralized WWTP. Existing WWTPs are under-utilized and can be fed under gravity.	Use existing WWTPs to treat the sewage.

The following tables summarize descriptive information of the project including the key information. .

Table 3 Project Summary of Key Information

General	
Name of the project	Kisumu Informal Settlements Sanitation
Country	Kenya
Sector	Sewerage
Date	April – July 2016
Narrative of the project	
Project objective	Increase access to sanitation in informal settlements
Technical features	Condominium sewerage
Population served by settlements	• Manyatta A: 55,000 capita • Manyatta B: 32,000 capita • Obunga/Nyawita: 17,000 capita • Obunga/Kanyakwar: 14,000 capita • Total: 118,000 capita (2016 Population) Design population: 206,000 capita (2039 Population)
Implementing agency	LVSWSB & KIWASCO
Investment amount	~ € 14.4 mln (Sewerage) ~ € 1.66 mln (Water supply) Total: ~ € 16 mln
Stand-alone project or part of larger project	Part of overall sewerage system. Remark: Wastewater and Sanitation Master Plan is needed to define the relations
Financial sustainability / business model (O&M costs coverage)	• O&M: Surcharge on water bill (via DMM or KIWASCO/pre-paid) Investments water supply & sewerage: 50% grant / 50% surcharge 0% interest, 10 years
Committed financing (international, government, municipality)	LVSWSB has prepared a € 90 mln investment plan for Kisumu. EIB, GoK and AFD (Agence Française de Développement/ French Development Agency) are planning to fund € 70 mln. These plans do not concern the area of the proposed HPI.

Summary	
Resettlement	Not applicable.
Consequences for poor	• Likely to be positive as the areas are populated with poor households. A careful process is needed to prevent that landlords increase the rent of improved housing. Increased rent is expected to lead to a replacement of the poorest of the poor by more affluent households (displacement effect); • Approximately 40% have already piped water supply and can be connected immediately. For the remaining 60%, access to piped water needs to be included in the project to assure proper functioning of the system. A beneficial side effect will be the improvement of health conditions.
Design issues	• Pending challenge is the geotechnical and topographical survey for the sewer line; • Careful design, flushing points and piped water supply is needed to assure enough wastewater for flushing the shallow sewers.
Environmental impact	Positive as currently untreated faecal sludge and wastewater of 118,000 persons is to be treated and disposed in an environmentally sound way.
Scope of the project (elements not covered)	• The project needs to include piped water supply to guarantee enough water for flushing; • KIWASCO has basic sewer maintenance equipment and procedures. At present these lead to destruction of installed sewers. Adequate equipment and procedures are a prerequisite for successful sewerage and need to be included in the project; • Solid waste is dumped haphazardly and usually ends up in the storm water cum grey water channels. During heavy rains blocked storm water drains cannot handle the runoff and the residential areas are flooded. The population 'solves' this problem by breaking the sewers.

	This results in blocked sewers and defunct sewerage. Hence, improved solid waste management and improved storm water drainage management is a prerequisite for adequate sewerage.
Sustainability	• KIWASCO is a reputable company and it is in a position to collect the bills efficiently; • Concerns on the ability of KIWASCO to operate and maintain the sewers adequately; • Concerns on the willingness and ability of the local government to improve solid waste management and maintenance of storm water drains.
Financing aspects	Despite funding of the infrastructure, landlords need to be willing and able to finance adjustments of the houses and household need to be willing and able to pay for increased rent due to water supply and surcharge.
Uncertainties	Landlords and the current Master Operators have a lot of power and act often independently from KIWASCO and the local government. It is a challenge to get them aboard of a government-initiated project. Therefore intermediate organizations (NGOs?) are needed to assure mutual trust and understanding.
Others	Literature: • Atkins: Draft Project Formulation Report Kisumu, September 2011; • Egis: Kisumu Water Supply and Sanitation Project, Technical and Management Support to LVSWSB, September: o Investment Plan in Water Supply and Sanitation, October 2014; o Final Project Preparation Report, September 2015.

The proposed site for the project location is shown in the Figure below.

Figure 3: Location Informal Settlements and WWTPs

The current situation is demonstrated in the Figures below.

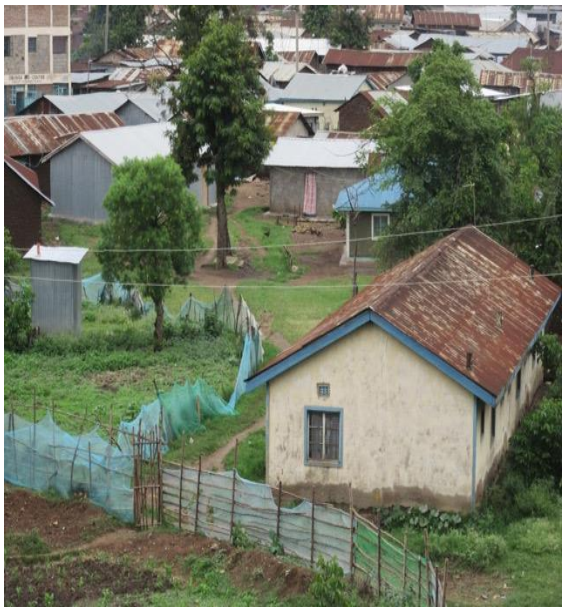


Figure 4: Typical Obunga Settlement: the Building in the Front Houses 10 Families

Figure 5: Lined Storm Water Drain Used as Open Sewer in Manyatta

Figure 5: Typical Shared Toilet Cum Shower Facility

Figure 6: Typical Latrine: Emptied at Nght into the Ditch

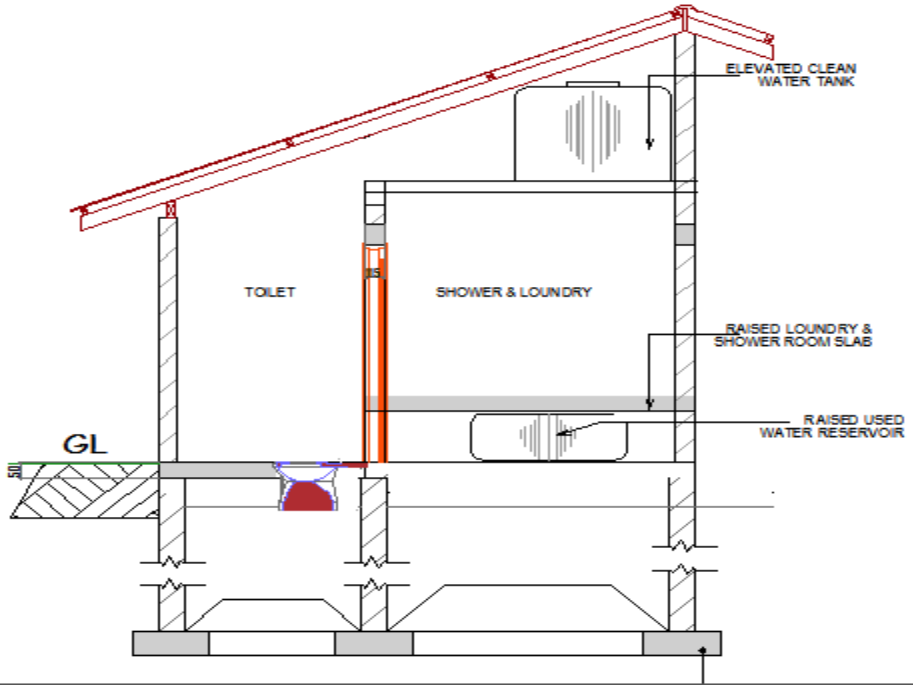


Figure 7: Ablution Block with a Raised Reservoir to Hold Recycled Water from Laundry and Shower for Flushing

This a shared facility as clarified in section 3.4.

Weighted criteria	
Effectiveness, removal BOD	Assuming a population of 110,000 capita, a wastewater production of 50 litres / capita per day and a per capita BOD_5 of 35 grams: the wastewater discharge is 5,500 m^3/day and with an expected reduction in terms of BOD_5 from 700 mg BOD_5/l to 50 mg BOD_5/l, the daily removal is 3.575 ton BOD_5/day
FIETS Sustainability	F = no regret investment I = training needed E = good T = many challenges with sewer O&M S = doubtful, might be positive
Water Quality Improvement	Excellent
Cost-effectiveness Euro/ton BOD removed	€ 14 mln / 3.575 ton BOD_5/day = € 3.9 mln per ton BOD_5 removed/day
Leverage of funds / co-funding	No other funding committed
Support stakeholders (Government, NGOs, local leaders)	There is a strong push for this project from LVSWSB and it has been on the radar since 2011, but implementation-wise there is only one NGO working on this, with mixed results.
Synergy with other projects	Not clear; there can be synergy with slum improvement programmes but the local government has not come forward with any ideas despite numerous visits.

Overall conclusion
The implementation is challenging. As other alternatives are worthwhile exploring, it is suggested to start with a pilot project in Manyatta to assess the viability of this approach and at the same time pilot other technologies and management structures.

1 Introduction

1.1 Background

Lake Victoria Basin Commission (LVBC) is intensifying its efforts on Integrated Water Resources Management (IWRM), in concordance with the sustainable development agenda of the East African Community (EAC). Cooperation in the international river basin of Lake Victoria is already strong; however, there is still an urgent need for regional coordination among the member states. Inter-sectoral and transboundary coordination of IWRM activities is still a challenge. Regulation and their enforcement regarding water resources and ecosystems protection are partly ongoing but the process is very long.

Although many programmes have been implemented over the last years, the planning, design and construction of water supply systems, wastewater treatment facilities and solid waste management do not keep up with population growth. Lack of sanitation facilities, open defecation and poor faecal sludge management lead to eutrophication and microbiological pollution. One of the consequences of eutrophication are high increases in growth of water hyacinths, which leads to disruption of water transport, water intake and hydropower generation, blockage of fish landings and de-oxygenation of the lake. Microbiological pollution is an important cause for water borne diseases in the region.

The LVBC is committed to develop IWRM for the basin using a step-by-step approach. For the short term a focus on the pressing and 'no-regret' issue of wastewater and sanitation has been chosen. At the same time steps are taken to develop towards a regional water framework management plan and a related regional priority investment plan. The focus on pressing and 'no-regret' has been translated in the concept of High Priority Investments (HPI). During the Inception Period this concept has been translated in three specific criteria that are presented in Figure 8.

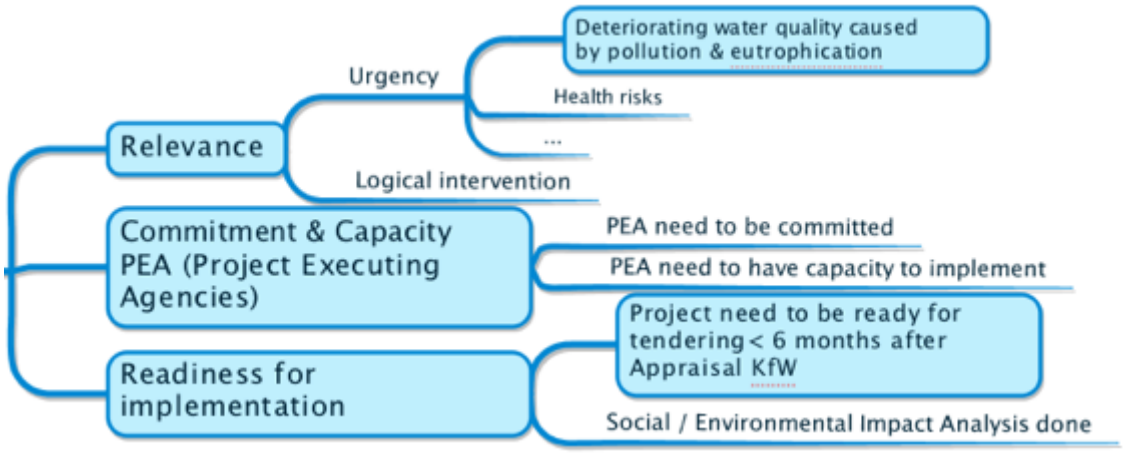


Figure 8: Criteria HPI Project

For the City of Kisumu, the HPI on Informal Settlement Sanitation has been selected for further elaboration in a feasibility study. The logic of the proposed HPI to the overall IWRM programme is the fact that open sewers in Manyatta are discharging into the Auji channel, a storm water drainage turned into an 'open sewer', which directly drains into Lake Victoria and therefore pollutes the lake. The Obunga settlements discharges untreated sewer into the Kisat River

channel which also drains into Lake Victoria. The channel and the rivers are major point sources of the Lake at the Winam Gulf.

1.2 Objective of this Feasibility Study

The selected HPI is to address urgent problems in wastewater and sanitation. Further investments in water and sanitation may follow: the 'pipeline' projects. In subsequent phases and in accordance with the availability of further funding, investments in other areas of IWRM could be envisaged. In the long run, the program is to lead to the establishment of a regional water framework management plan and related regional priority investment plan.

The objective of this feasibility study is to provide all necessary information to the funders to execute the appraisal and at the same time setting a standard for pipeline projects. As KfW is the main potential funder, the feasibility study follows the *'Appraisal Guidelines for Financial Cooperation Projects Wastewater / Sanitation (KfW, April 2013): Programme Proposal Part A (Priority Area Selection), Part B (Financial Cooperation Module)'*.

The specific scope of the study is to prepare a preliminary design and assess the feasibility of a condominium sewer system and decentralized septic sludge management including development of Biogas generation system for high-density low income areas Manyatta and Obunga informal settlements with a low coverage of sanitation systems.

1.3 Objective of the Proposed High Priority Investment (HPI)

The objective of the HPI is to '*Increase access to sanitation in Manyatta and Obunga informal settlements'* in Kisumu thereby reducing the pollution load into Lake Victoria.

2 Review of Current Conditions

This chapter provides an overview of all relevant basic information on the country in general and the wastewater and sanitation sector specifically.

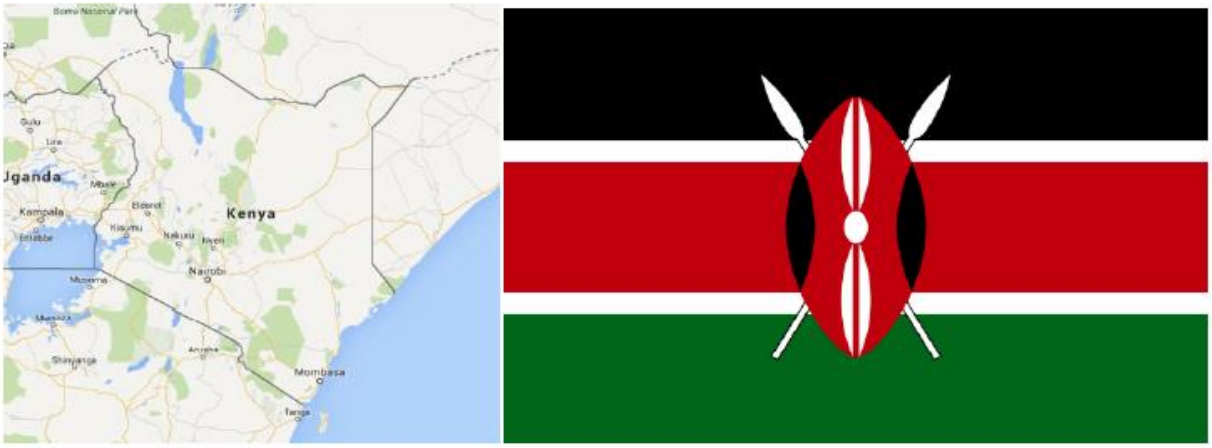


Figure 9: Location Kenya and National Flag

2.1 Introduction

Kenya has a devolved system of government, which results in two forms of governments, the national and county government. In relation to the county government, Kenya is sub-divided into 47 counties as Figure 10 illustrates. Each county has in place a county government and an administrative centre.

Five of the 47 counties of Kenya border Lake Victoria. These are Busia, Siaya, Kisumu, Homa Bay and Migori Counties. Of these, Kisumu is the county of interest under this report; and its administrative centre is Kisumu Town.

The 2009 census results, which are the latest for Kenya, inform that the number of urban centres in Kenya with a population of 2,000 and above persons is 215. Of these centres, Kisumu in Kisumu County is the third most populous centre, after Mombasa in Mombasa County, and Nairobi in Nairobi City County. Including Nakuru in Nakuru County, and Eldoret in Uasin Gishu County, these centres form the top five most populous centres in Kenya. As the table in Appendix 3 illustrates, the 2009 census results shows, their combined population was slightly over a third of persons enumerated from all the 215 urban centres in Kenya. Of the total population of persons enumerated from these key centres, nearly three fifths was located in Nairobi. Nairobi is the largest urban centre in Kenya in terms of population, infrastructure and functions; and, this primacy position is expected to be sustained in the future. It is also the capital city of Kenya. Kisumu County is located northwest to Nairobi City County.

Figure 10: Counties Kenya

The 2009 census results of Kenya grouped persons in the 215 urban centres in Kenya into core urban, peri-urban and rural populations respectively. The administrative centre of Kisumu County, i.e. Kisumu, has all three types of populations and, of these, its core urban population is the largest, comprising nearly two thirds of the night population of individuals in the city. Also informed by the 2009 census results is that Kisumu County had an estimated population of 968,909 persons distributed in 226,719 households. Slightly over 40% of this population of persons is to be found within the boundary of its administrative centre; and it is distributed in three of the seven constituencies that comprise Kisumu County. These three constituencies are Kisumu Central, Kisumu East, and Kisumu West. The other four are Seme, Nyakach, Nyando and Muhoroni. See Table in Appendix 4: Population Tables.

2.2 Facts and Figures Kenya[1]

Government type:	**Democratic republic**
Political situation:	Kenya gained independence from Britain in 1963, after which KANU under President Jomo Kenyatta and President Daniel Moi ruled until 2002. Tribalism and nepotism initiated during colonial rule characterized the country during this period and the violence during

[1] *Source: Positioning Survey for the Dutch water sector in Kenya, Aidenvironment, commissioned by RVO/NWP, April 2015*

	the elections in 2007 still followed some of the social cultural fold lines that have always divided the country. During the constitutional reform process in the years 1999-2010, the political and administrative framework of the country has been restructured. This was done with the aim to reduce regional imbalances and inequality between ethnic groups.
Stability:	The memory of the violence that followed the 2007 elections still generates anxiety over the stability of the country. The current regime has the support of the majority of the people. The ICC has cleared the current president off all accusations related to post election violence. Internationally, the border with Somalia continues to be a source of tension and violence. Related to this conflict are the attacks and bombings in Nairobi and Mombasa that were linked to Al Shabaab.
Language:	English, Kiswahili, local native languages
Population:	45,010,056
Population growth:	2.11%
Economic growth (GDP growth in %):	5% (2014), 4.7% (2015), 4% (2016)
GDP (PPP):	USD 79.9 billion (2013) comparison to the world: 82
GDP (PPP) per capita:	USD 1,800 (2013)
Unemployment rate (in%):	40%
Inflation rate + forecast 2020 (in %):	6.09% (2014), 7.33% (2015), 7.33% (2020)
Foreign direct investments (in % of GDP):	0.9%
ODA in % of GNI:	5.3%

2.3 Facts and Figures Kisumu

Kisumu Town, which presently holds city status, is a significant commercial/trading, industrial, communication and administrative centre of Kisumu County, as well as of the Lake Victoria Basin. Its significance predates arrival of colonial rule in Kenya. Presently, Kisumu Town[2]:

- Has a road transport connection with adjacent towns such as Kericho, Kakamega, Homa-Bay, Kisii, Siaya, Busia and the Sugar belt satellite townships of Muhoroni, Awasi, Chemelil, Miwani and Nandi Hills;
- Is served by Kisumu International Airport, which has regular flights to Nairobi. This Airport is one of the busiest airports in Kenya;
- Is on the convergence point of a Trans African Highway that connects to Uganda and Tanzania and, by extension Rwanda, Burundi and Congo DRC in the west, Zambia to the south and Sudan to the north;
- Is an inland depot for cargo serving the wider great lakes region. Lake Victoria ferries operate from the Port of Kisumu which is located in Kisumu Town to Mwanza and Bukoba in Tanzania and, Entebbe and Jinja in Uganda, thus linking the Port of Mombasa to the wider great Lakes region; and,
- Hosts the headquarters of the Lake Basin Development Authority (LBDA) of Kenya and, the Lake Victoria Basin Commission (LVBC) of the East African Community.

[2] Kisumu City Development Strategies (2004-2009). Centre for Development and Planning, Kisumu City Council. Invest in Kenya: Focus Kisumu. 2007. The Earth Institute, Columbia University. New York

Figure 11: Aerial view Kisumu

Figure 12 Aerial View Kisumu

Kisumu Town has three wastewater drainage districts, namely: Eastern, Central and Western Drainage Districts. The Eastern Drainage District has a very low coverage in terms of sewer network, estimated at 15%. The district however has a good water supply coverage (i.e. the district is described as fully covered by piped water supply).

Kisumu has two WWTPs: Kisat and Nyalenda that were rehabilitated between 2005 and 2007.

Figure 13: Main Areas Kisumu

The Project Area is situated in Kisumu Central and Kisumu East Constituencies. As Table 4 illustrates, these constituencies have the highest population density in the County, with Kisumu Central Constituency leading at 5,165 persons per km^2. The specific regions of these two constituencies that are identified as the Project Area are four informal settlements, namely: Obunga, Nyawita, Manyatta A, and Manyatta B Settlements. Manyatta A is located in Manyatta A Sub-Location in Kisumu Central Constituency; Obunga and Nyawita are in Nyawita Sub-Location in Kisumu Central Constituency; and, Manyatta B is in Manyatta B Sub-Location in Kisumu East Constituency.

Table 4: Estimated Population of Kisumu County, 2009 Census[3]

	Constituency Name	Number of Wards	Number of Sub-Locations	Constituency Population	Approximate Area (Km^2)	Density (persons/Km^2)
1.	Kisumu Central	6	9	168,892	32.70	5164.89
2.	Kisumu East	5	12	150,124	135.90	1104.67
3.	Kisumu West	5	20	131,246	212.90	616.47
4.	Seme	4	28	98,805	190.20	519.48
5.	Nyakach	5	30	133,041	357.30	372.35
6.	Nyando	5	36	141,037	413.20	341.33
7.	Muhoroni	5	35	145,764	667.30	218.44
Total		**35**	**170**	**968,909**		

	Male	Female	Total	Households	≈ Area (Km^2)	Density (persons/Km^2)
Count	**474,760**	**494,149**	**968,909**	**226,719**	**2,086**	**464.48**
Percent	49.00	51.00	100.00			

2.4 Sewerage and Sanitation Coverage in Kisumu[4]

Kisumu Municipality is currently served by two sewage treatment plants and a network of sewer lines. The total sewered area is reported in the LTAP (Long Term Action Plan financed by AFD) to be about 600 ha (approximately 8% of the total area supplied with water) and the number of house connections at slightly over 6,400. These figures are likely to increase with the partial completion of works planned under LTAP Package 3, although no accurate and updated figures could be obtained at this stage, except for the coverage rate (by conventional sewers), which was reported at 12%. The sewerage system in Kisumu falls into three distinct Wastewater Treatment Districts (WTD):

- **Central WTD**: covers an area of approximately 390 ha (437 ha after completion of LTAP Package 3). It collects wastewater generated in the north west of the Old Town by gravity, and from the low lying areas along the shores of Lake Victoria through pumping:
    - Sunset Hotel pumping station (1979): collects wastewater from the neighbourhood of the Sunset Hotel, Nyanza Club and some parts of lower Milimani residential area;
    - Kendu Lane Pumping Station (1967): collects wastewater from the area around the Railway Station, the adjacent houses and the lower elevation commercial establishments;
    - Mumias Road Pumping station (1972): collects wastewater from the area around the airport and the adjacent industrial establishments.

[3] Independent Electoral and Boundaries Commission (IEBC). 2012. Final Report of Boundaries of Constituencies and Wards Gazetted on 07-03-2012; and,
https://opendata.go.ke/Population/Census-Volume-1-Question-1-Population-Households-a/wd27-eki2

[4] Source: Egis, Kisumu Water Supply and Sanitation Project, Technical and Management Support to LVSWSB, Final Project Preparation Report, Version 1, September 2015.

All these pumping stations were rehabilitated under LTAP Package 3. Discharges are to the conventional sewage treatment plant at Kisat, which includes 2 additional pumping stations (sludge and re-circulation). The sewer network in the Central WTD ranges in diameter from DN150 to DN600 and is of combined type in the Central WTD, due to the historical development of Kisumu.

Consequently, Kisat treatment works are simply by-passed during heavy rains.

- **Eastern WTD**: covers an area of approximately 214 ha (1,358 ha after completion of LTAP Package 3) and collects wastewater generated in the southeast of the Old Town by gravity, through a network ranging in diameter from DN175 to DN675. There is no sewage pumping station in the area. Wastewater generated from the district is mainly domestic and discharges into Nyalenda Stabilization Ponds;

- **Western WTD**: covers the areas to the south west of the airport but currently contains no sewer network. Proposals have been initiated under LVEMP II to develop a new sewer network with a dedicated treatment plant for the area covering Korando 'A' and 'B', Kogony, Bandani and Kanyakwar (totalling 5,140 ha).

The present sewer network coverage is very low, 12% after completion of LTAP Package 3. The unserved population uses various forms of on-site sanitation; latrines, septic tanks and soakaways, eco-san, public toilets or the bush.

From discussion with LVSWSB and KIWASCO, it was apparent that the next project:
- Should focus on increasing coverage by conventional sewers, rather than providing additional onsite sanitation, an area where many NGOs already intervene;
- Should not include individual connections, which will be considered by KIWASCO on a case-by-case basis, depending on the population served, the level of income determining the type of connection;
- Individual connections for medium to high income households;
- ***Should include condominium sewers in informal settlements, which is seen as a good option given the high density, high water table, low permeability of the soil and proximity to the conventional networks.***

A critical aspect of network coverage is the situation within informal settlements (the "slum belt" circling the city from the South of Milimani to the eastern tip of Obunga) that are still largely un-sewered:
- Nyalenda was meant to drain by gravity to a gravity main discharging into the adjacent stabilization ponds, but with the modification that occurred during project implementation (pumped main), alternative solutions must be sought for this area;
- Manyatta was also included in LTAP Package 3 works, but most of the sewers planned for this area will not be implemented;
- Obunga, reported as the most affected with almost 40% of the residents lacking access to proper latrines (reasons: loose soils and high water tables), was not targeted by LTAP works and remain totally unsewered.

Need for a wastewater master plan

The analysis of previous design reports (LTAP and LVEMP consultant) has shown that many areas of uncertainty remain regarding calculation of sewage flow, actually sewered areas, adequacy between the proposed sewer network and the treatment capacity at the system's outlets, suitability of the intended treatment process with regards to land availability, etc.. The conclusion is that, to avoid piecemeal approach towards sewage management, the immediate need would be to produce a clear master plan. The plan should:
- Provide for coordination of the sewerage system:
    - Re-defining the boundaries of Central, Eastern and Western WTDs;
    - Ensuring that sewer network development and upgrading aligns with the planned and available sewage treatment capacities within each treatment district;
- Clearly identify the existing system and the gaps in the system in order to draw up workable proposals for expansion;

- Consider proposals by earlier studies and review these based on how practical they are;
- Investigate options for:
    - Decentralized treatment;
    - Connections to users: where individual connections are possible, where condominium sewers (equivalent to DMM for wastewater) should be preferred, etc.

Proposals should be based on the following:

- Population to be served by the system in the future year;
- Capacity and condition of the existing systems to carry future flow;
- Upgrade requirements for the system to cope with future flow;
- Availability and feasibility of land for further expansion;
- Possible diversion of flows between the existing catchments to maximize efficiency;
- Minimization of O&M requirements to ensure sustainability;
- Location of new treatment works for sewage with considerations of land requirements and treatment technology. This should look at the most feasible treatment method on basis of O&M requirements;
- Financial and economic viability.

In addition to the above, the proposed master plan study should determine in detail the necessity, viability and feasibility of the development needs stipulated above.

2.5 Sanitation Situation in Informal Settlements in Kisumu

Figure 14 shows the spatial distribution of the four informal settlements identified as the Project Area. As Figure 15 illustrates, these informal settlements are low-income areas; and Obunga is the poorest of all. The 2009 census results inform that, the four identified informal settlements are high-density informal settlements. The 2009 census results show that about a third of households in the settlements are connected to safe water supply network managed by Kisumu Water and Sewerage Company (KIWASCO). The main mode of human waste disposal is carried out on-site, mainly (80%) through traditional pit latrines.

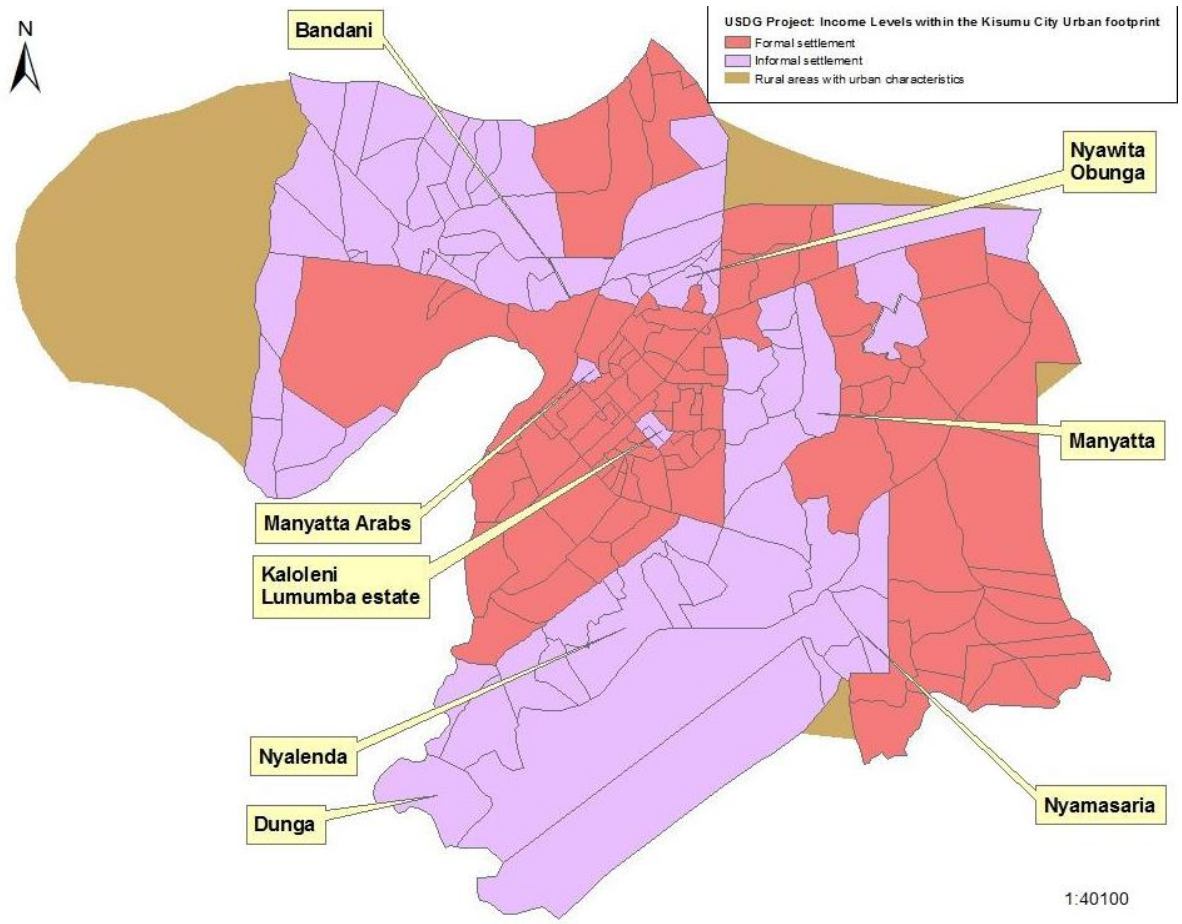


Figure 14: Formal and Informal Settlements

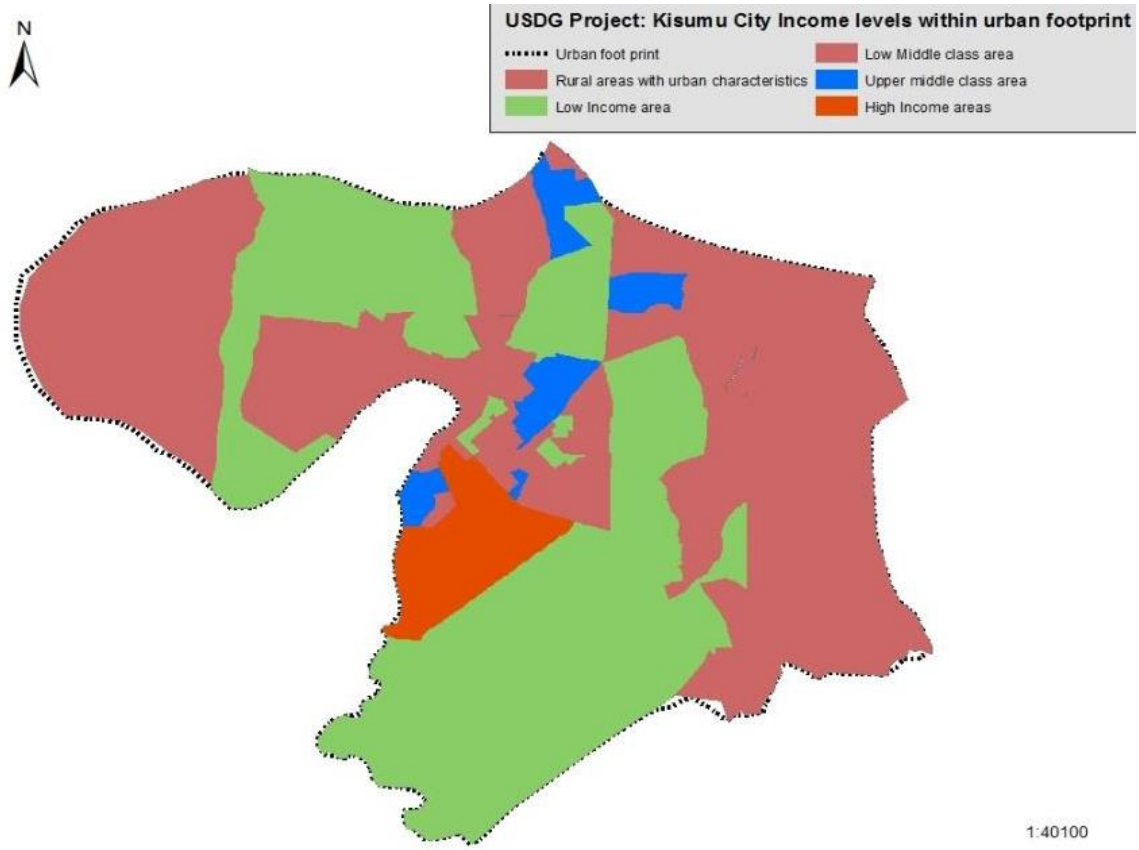


Figure 15: Kisumu Income Levels

Delegated Management Model (DMM). As indicated in the previous section, condominium sewers are expected to be operated on models equivalent to DMM for drinking water supply in low-income areas. DMM is the approach KIWASCO has taken to improving water utility services in the informal settlements.

Through this approach:

- KIWASCO sells bulk water to community contractors, designated *'master operators (MOs)'*, at a bulk flat supply tariff of KES 25 per cubic metre. The MOs then sell the water to households or water kiosk vendors at a recommended supply tariff set by KIWASCO. This tariff is graduated as follows: a) 0-6m^3/month, a lump sum charge of KES 180 and, b) 7-21m^3/month KES 35 per each cubic meter consumed;
- The MO is responsible for minor maintenance such as repair of leaks, and management of customer interfaces;
- KIWASCO has managed to install a dense water supply network within the low-income settlements with DMMs.

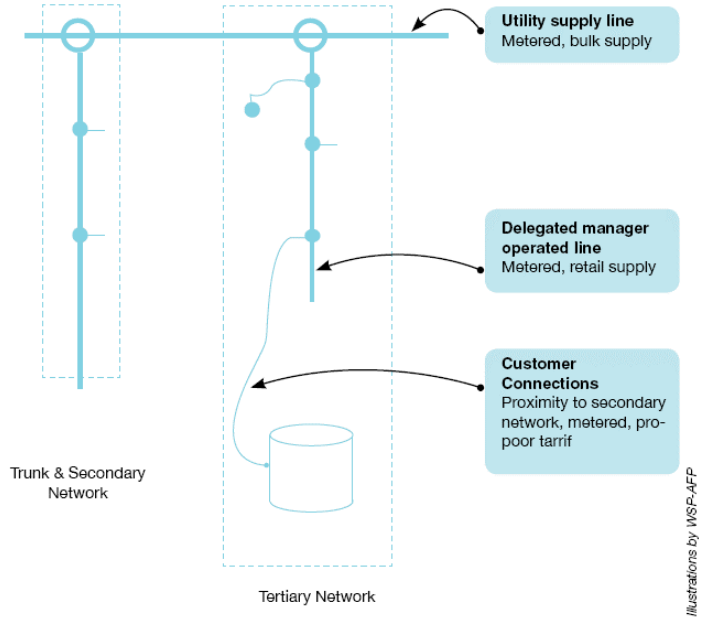


Figure 16: Delegated Management Model (Source: Water and Sanitation Programme. 2009.

Improving Water Utility Services through Delegated Management: Lessons from the Utility and Small Scale Providers in Kisumu, Kenya

The bulk supply tariff offered to MOs, as well as the tariff offered to households and water kiosk vendors is subsidised. Connection to the households as well as the water kiosk vendors is also subsidised.

Through the approach of DMM, the MO is a Community Based Organisation (CBO). This CBO that KIWASCO works with has a fully-fledged office. It bills, connects, disconnects, and collects money. In other words, it operates as a 'small KIWASCO' within its area of jurisdiction. For example, should a potential household consumer need a direct connection, this potential household consumer approaches the closest DMM office to fill a form and pay the connection fee of KES 2,700, of which KES 1,000 is the meter deposit. This meter deposit is credited into KIWASCO account upon which KIWASCO releases the meter. All meters used are the property of KIWASCO. The DMM then sends someone to KIWASCO to collect the meter. KIWASCO also releases to the DMM 8 PVC water pipes, each 6 m' long and the DMM connects the potential consumer. To enable this, each DMM employs a plumber.

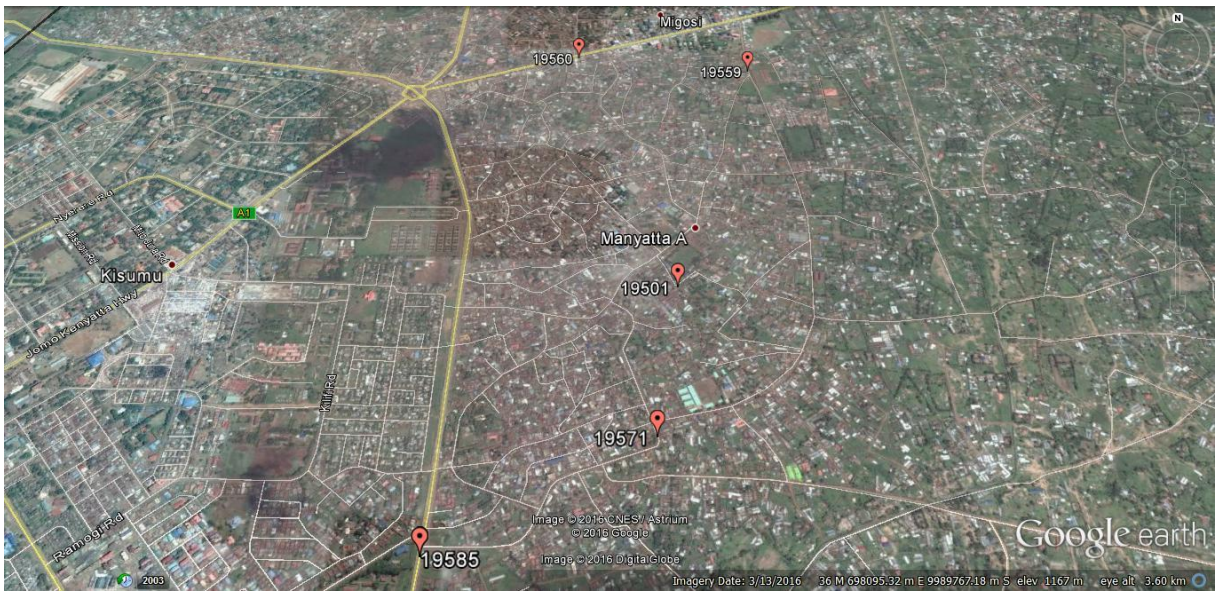


Figure 17: Location of Manyatta 'A' Resident Association within Manyatta A Settlement
The boundary of Manyatta A Settlement is defined by roads – Nairobi Road (label 19585), Kibos Road (label 19560), and the road that starts from Kibos Road at about label 19559 through label 19571 and joins Nairobi Road at label 19585).

Example of Master Operator (19501)

Office of Manyatta A Resident Association: Manyatta A Settlement has 6 units (villages), and these have united to form an umbrella association labelled Manyatta A Resident Association.
The Association has about 9 task forces. At the unit level, each unit also has about 9 task forces. Each task force at the umbrella association level is composed of one representative from a corresponding task force from the unit level.
The MO of the Settlement is the CBO, Manyatta A Community Water and Sanitation. The water and sanitation task force at the Association level forms this CBO. Its members are from all the units of the umbrella association.

In April 2016, KIWASCO had a total of 33 MOs. In Obunga Informal Settlement there are two, of which one MO serves 159 direct household connections and the other 123, to give a total of 282 direct household connections. Additionally, there are 42 water kiosks in the settlement. Manyatta A has three MOs, where one MO serves 134 direct household connections; the second, 37; and the third, 42 – to give a total of 213 direct household connections in the settlement. Manyatta B also has three MOs, where one serves 98 direct household connections; the second, 29; and the third 53 – to give a total of 180 direct household connections in the settlement. According to KIWASCO, the projection of customers that a MO can comfortably manage is 180. Also according to KIWASCO, one advantage of the DMM approach is that all beneficiaries of direct connections through the MO are involved in the management of the water supply network. For households, the fact that they are not billed a flat rate makes them keen to ensure their meters do no leak. The MO and water kiosk vendors ensure that their meters do not leak. The MO also works hard at ensuring the meters are not vandalised. Vandalism of water meters is one of the major challenges, which the MOs face.

According to KIWASCO, on the average, the amount of water consumed by a household per month is between eight and nine cubic meters. In the settlements that are poor, the average amount is less.

2.6 Problem Analysis

The residents in the informal settlements are facing the following problems:

- Land for building a pit latrine and bathroom in the informal settlement is getting scarce;
- Constructing a septic tank is expensive. Additionally, similar to the pit latrine, it requires space which is getting scarce in the informal settlements;
- The informal settlements are in an urban set-up. Thus, when a pit latrine fills up, the best option available to an owner of a pit latrine is emptying the latrine. In the informal settlements, usually informal exhauster services are sought. They involve manual emptying of the pit latrines using buckets, and untrained individuals undertake the activity. These do not use protective clothing while at the job, and they dispose the contents into storm water channels, which eventually drain into Lake Victoria.

Figure 18: An Example of a Combined Pit Latrine and Bathroom in Obunga Informal Settlement that is Competing for Space with a Public Passageway due to Lack of Land

***Figure 19: Auji Channel*[5]**

The manual emptying is a health hazard and the activity is reported to be banned by the Public Health Department of Kisumu County Government. The Public Health Department encourages use of formal exhauster services. Property owners in the formal settlements are reluctant to use them as:

- Formal exhauster services cost between KES 5,000 and KES 8,000 per pit latrine. This is expensive for two main reasons: (1) pit latrines in the informal settlements are shared facilities. As ***Figure 20*** illustrates, several households in the informal settlements are located on one compound described as a plot. The households in one plot share one pit latrine, thus increasing the rate at which the pit latrine fills up, hence the cost of exhauster services in a year; (2) the rate at which a pit latrine located in a plot fills up is most pronounced during the rainy season. The water table in Kisumu is high. Thus, when it rains, the pit latrines fill up faster, increasing the number of times of exhauster services are required, thus the cost of exhauster services per year;
- Formal exhausters do not like emptying pit latrines either. Many times the walls of the pit latrines collapse while at the job. Walls of the pit latrines in the informal settlements are not lined – they are constructed of earth.

[5] Channel receives a mix of raw sewage and storm water, then directly discharges this into Lake Victoria. Top Left: A toilet and bathroom trained to discharge wastewater directly into the Channel; Top Right: A storm water drainage trained to discharge directly into the Channel; Bottom: Downstream - A person using the wastewater from the Channel to wash a motorbike. Children also play around the Channel, some even coming into contact with the wastewater. The informal settlements directly discharging into this channel are mainly Manyatta B, Car Wash, and Koranda.)

Figure 20: Example of Two Plots with Households Sharing One Sanitation Facility in Manyatta A Settlement

Figure 21 presents the 'problem tree' associated with the sanitary problems in the informal settlements.

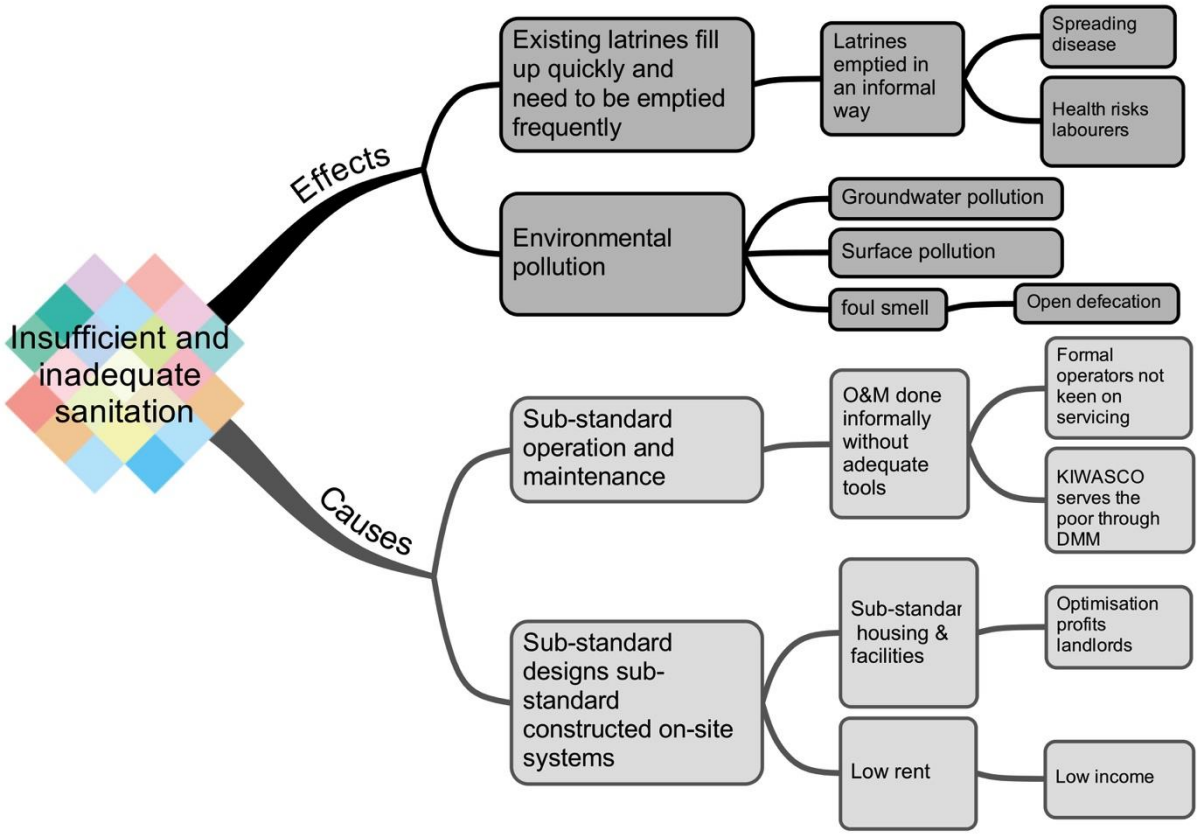


Figure 21: Problem Tree Inadequate and Insufficient Sanitation Low-Income Areas

It is expected that the High Priority Investment project on sanitation in informal settlements in Kisumu will remove the underlying causes of the present problems. This is explained in the following table.

Underlying cause for problems associated with insufficient and inadequate sanitation: sub-standard constructed on-site sanitation and O&M,	**Solution: sanitation that technology wise and management wise fits the informal areas: shared ablution blocks (shower, toilet and laundry) for every block of rented rooms connected to condominium sewerage.**
Formal operators not keen on servicing the poor and KIWASCO follows a DMM approach for servicing the poor.	Delegated Management Model for ablution blocks and condominium sewerage.
Landlords optimize the profits.	External funding for ablution blocks operated and maintained by a MO: grant and loans to MOs.
Low income.	Low-cost technologies, permanent subsidy and/or valorisation.

2.7 Other Donor Involvement and Donor Coordination

As indicated in section 2.4 all donor involvements are focused on sewerage. Currently, the main donors are AFD and EIB.

3 Description of the Proposed HPI

3.1 KIWASCO'S Approach Towards Improvement of Sewerage Services in the Informal Settlements in Kisumu

As far as sanitation for informal settlements is concerned, KIWASCO has the condominium sewerage approach in mind that is piloted with Pamoja Trust: Pamoja Trust is a local Non-Governmental Organisation (NGO) with countrywide outreach, hat has piloted sewerage infrastructure into two Informal Settlements: Nyalenda and Manyatta A. In Nyalenda, it is piloting with one DMM – Simba Kogelo MO; and, in Manyatta A it is with Manyatta A Community Water and Sanitation MO. In Manyatta A Settlement, the pilot project is to be found in one of the units of the settlement, Magadi Village. The pilot project, has the following specific objectives:

- To bring affordable sewerage services closer to households in the informal settlements;
- To involve an operating MO in managing sewerage services in its area of jurisdiction, but on behalf of KIWASCO – similar to the approach adopted on water services;
- To obtain lessons learnt for use in expanding the services to other informal settlements within KIWASCO's jurisdiction.

In Magadi Village, through the pilot project, the goal was to install six lateral sewer lines. However, only four were implemented due to a shortage of funds. The lateral lines installed are 6" diameter, and were provided by Pamoja Trust. A contractor employed by the Pilot Project laid the main lines. To facilitate its work, the contractor employed a local construction workforce to assist by digging the trenches and other related works to sewerage infrastructure expansion. Under this contract, the contractor was not mandated to do individual household connections. These are at present done by KIWASCO. According to KIWASCO, individual household sewerage connection is too complex to leave to a contractor. However, KIWASCO is presently in the process of building capacity of the MO's plumber to manage sewer connections. The individual household connection fee charged is a deposit of KES 6,200, which is, at present, credited to KIWASCO. As at the time of collecting data for this report, some individual household connections had been established, and some households were waiting for their connections. Also, KIWASCO had yet to start billing sewerage services, which is done through the drinking water bill.

As Figure 22 illustrates, the lateral lines are on road reserves within the settlement. Manyatta A Settlement is a planned area. It has been surveyed, and landowners have title deeds as official documents giving proof of landownership. Subsequently, there exist public passageways through which lateral lines can be passed with minimal social concerns. Hence, involuntary displacement of households is not likely. It is important to note that the trunk sewer is within reach of the settlement. These observations were also made in the other informal settlements identified as the Project Area to implement the HPI selected for Kisumu.

Figure 22: One of the Lateral Lines Implemented during the Pilot Project Expanding Sewerage Infrastructure into Manyatta A Settlement

3.2 Location

The location of Obunga and Manyatta is presented in Figure 23.

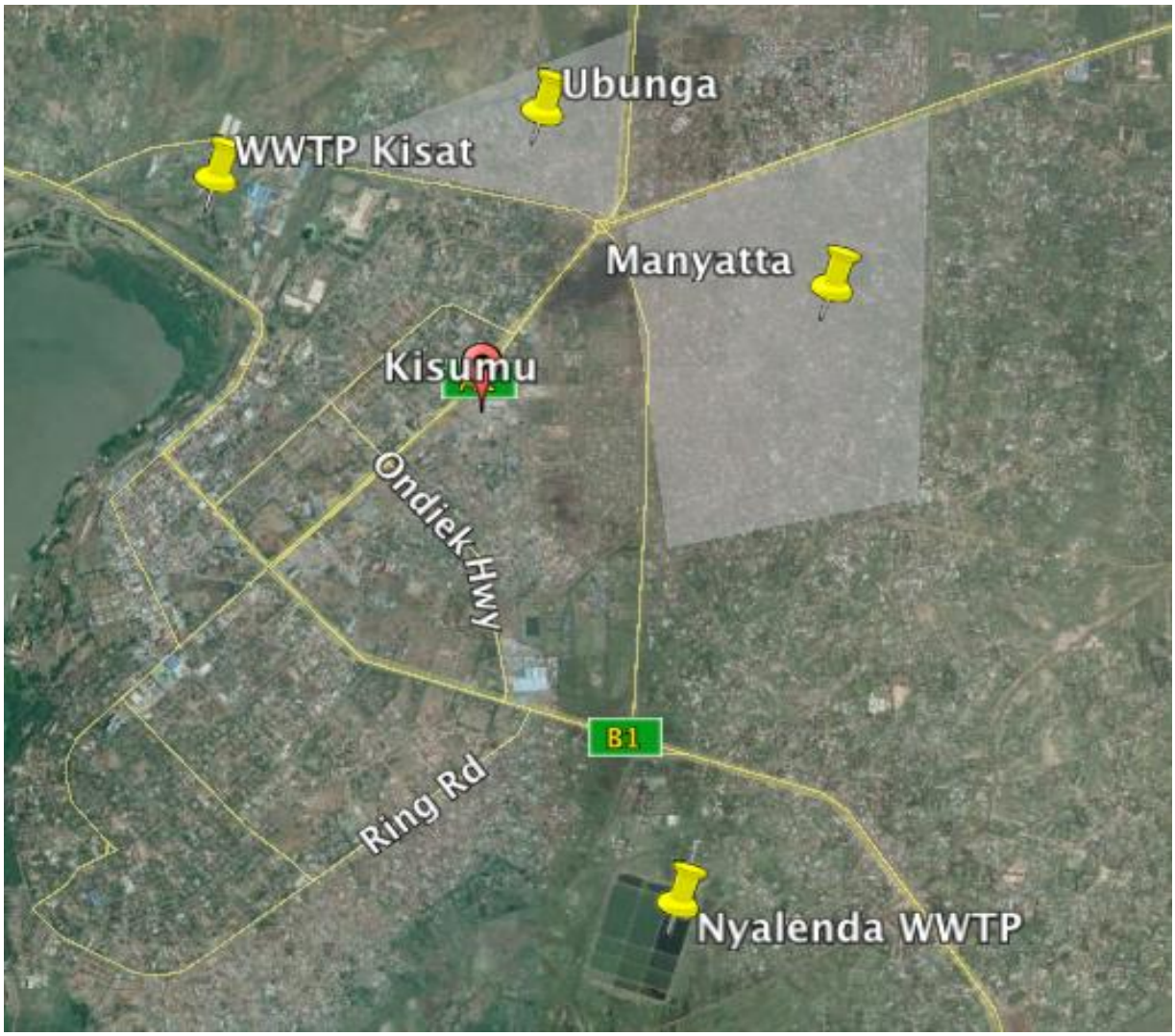


Figure 23: Location Informal Settlements

3.3 Sewerage

Figure ***24***,Figure ***25*** and Figure 26 show the sewer lines that serve the informal areas and connect them to the existing sewerage network.

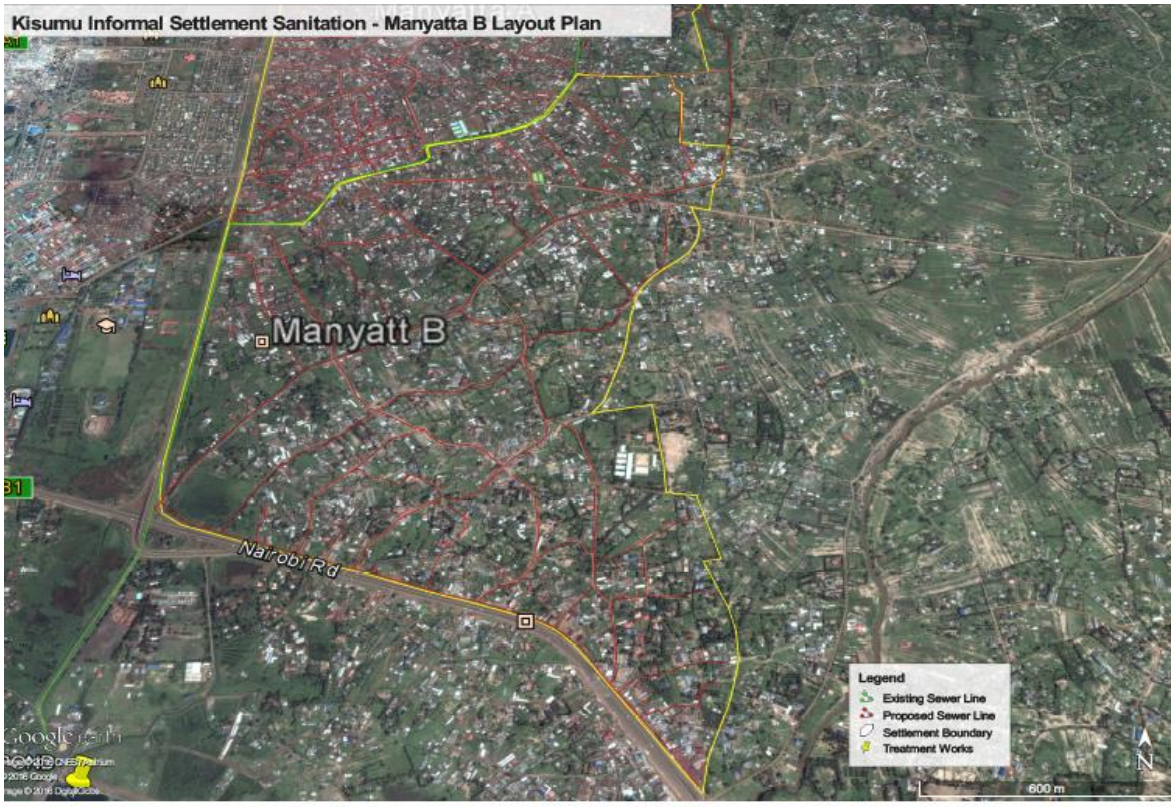


Figure 24: Manyatta A Sewer Lines

Figure 25: Manyatta B Sewer Lines

Figure 26: Obunga Sewer Lines

3.4 Ablution Blocks

The ablution blocks follow the designs that are currently implemented successfully in the informal settlements in Nairobi; see Figure 27 and Figure 29. The idea of shared facilities is based on the fact that each plot has one area reserved for sanitation. By using recycled water for flushing the pipes, residents save on water bills.

Figure 27: Ablution Block in Nairobi Informal Settlement as an Example for Kisumu

Figure 28 Ablution Block in Nairobi Informal Settlement

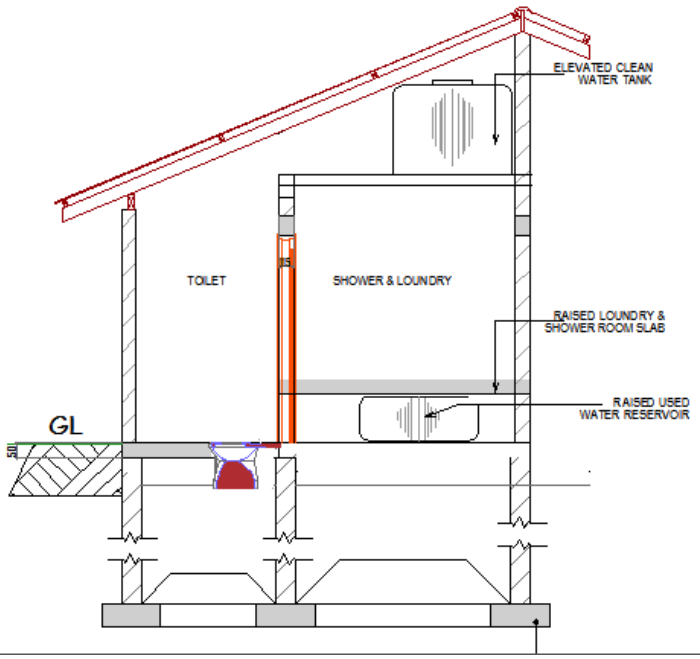


Figure 29: Ablution Block with Raised Reservoir to Hold Recycled Water from Laundry / Shower for Flushing

3.5 HPI Objective and Indicators

The objective of the HPI is to *'Increase access to sanitation in informal settlements'.*

The overarching objective is that systems in Kisumu fulfil the Sustainable Development Goal on sanitation (Goal 6): *"By 2030, improve water quality by reducing pollution, eliminating dumping and minimizing release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally".*

The indicators and assumptions that relate the HPI to this objective are presented in Table 5.

Table 5: Indicators and Assumptions HPI KISS

Indicator	Assumption
In December 2018 Kisumu has piloted a sanitation system that technology wise and management wise fits the informal areas: shared ablution blocks (shower, toilet and laundry) for every block of rented rooms connected to condominium sewerage for 25% of Manyatta 'A' (25% of 11,000 hh / 55,000 persons, say 275 ablution blocks).	• Areas can drain under gravity into the existing sewer network; no pumping required; • An adequate intermediate (NGO) organization can interact with KIWASCO and the master operator (MO); • Enough MO's can be identified; • Enough landlords are willing to cooperate and commit themselves to freezing the rent of the housing; • Piped water supply to 100% of the identified area. • Tendering for design and construction is successful • Funds for implementation released
In 2021, whole Manyatta 'A' is covered (an additional 825 ablution blocks, total population 55,000 capita), in 2024 Manyatta B (700 blocks, total population 90,000 capita) and in 2027 Obunga (700 block), 100% (110,000 capita)	• Successful pilot; • Release of funds.

3.6 HPI Cost

The investment is composed of:

- Construct 18 km sewer line in Manyatta 'A', 20 km sewer line in Manyatta 'B' and 13 km sewer line in Obunga settlement. Topographic and geotechnical survey to be undertaken for the sewer line;
- Construct 1,128 ablution blocks in Manyatta A, 703 ablution blocks in Manyatta B and 690 ablution blocks in Obunga settlement;
- The following areas can be connected by gravity: 11,300 households (hh) in Manyatta A, 7,000 hh in Manyatta B, and 6,900 hh in Obunga. Total 25,200 hh;
- Total costs: € 14.4 mln. for improved sanitation;
- Augmentation piped water supply: € 1.66 mln.;

Total costs: € 16 mln (see Table 6)

Table 6: Summary Costs

No	Description	Amount € Mln.
1	Total Direct Investment: Sewer line and ablution blocks	**€ 12.86**
2	Capacity building	**€ 0.13**
3	Construction Supervision	**€ 1.29**
4	Project Management Unit	**€ 0.13**
5	**Total sanitation improvement**	**€ 14.40**
6	**Augmentation of piped water supply**	**€ 1.66**
7	***Grand total***	**€ 16.06**

3.7 HPI Financing Plan

It is assumed that for the HPIs, the investment costs will be covered by the development partners through a contribution. These investment costs comprise the hardware for the equipment, facilities, pipes and electrical-mechanical installations (if any). Also included in the investment costs are the preparatory costs, tender & detailed design costs and training costs that are needed to train staff to run the facilities. Access roads, electricity and other public services are not included in the investment costs; these are to be provided by the government.

It has been assumed that the financing will be grant financing, because KfW and EU are the initiators of the feasibility studies that are presently executed. However, if other financiers will step in or will co-finance, other financing modalities can be incorporated. If grant funding is to be replaced by loan financing or equity financing, the financial viability of the HPI projects will be lower as financing costs have to be included in the calculations.

Any follow-up financing of investments later on in the project will have to be financed through non-project sources. This could be internally generated funds of the implementing agency, contributions by the government, commercial financing (if possible) or other sources.

Depreciation is included in the calculations to ensure that at the end of the economic lifetime of the project, sufficient sources will be available for new investments.

As to the O&M costs, these have to be covered by the project, through the revenues generated by the project. The full-cost recovery ratio (FCR) should therefore be positive; the revenues divided by the operational costs and depreciation costs should be larger than 1.

3.8 Relation with the National Strategy

The strategic goal of the National Water Services Strategy (NWSS) (2007 – 2015) is to '*Reach through sustainable waterborne sewage collection, treatment and disposal systems 40% of the urban and 10% of the rural population by 2015'*.

Strategic actions:

- Increase sustainability of sewerage systems and investments through ensuring that development funding has a waste water component;
- Improve treatment of effluent by encouraging PPP and government to establish facilities;
- *Sewerage systems shall be managed by commercially oriented WSPs;*
- WSBs and WSPs subsidize sewer development for the urban poor;
- Develop common understanding of roles of different Ministries/departments at all levels in the basic sanitation promotion and development;
- MWI to define roles that WSPs and private sector in the water sector can play in basic sanitation.

3.9 Relation with the City Plan

The HPI fits in the sewerage and sanitation plans as indicated in the reports prepared by Atkins and Egis. See text boxes below.

Simplified (Condominium) Sewers

The LTAP idea to install simplified or condominium sewers appears to be a good one, given the high density of some informal settlements, high water table, low permeability during the rains, proximity to the conventional networks and spare capacity at the soon-to-be refurbished treatment ponds.

A 110 mm condominium sewer can connect up to 200 households of 5 people (1,000 users) with a gradient of 1 in 200 m (this assumes a peaking factor of 4, which is reasonable). Note that condominium sewers rely on frequent "waves" of high flows to push solids along, rather than constant scouring as in conventional sewers. This type of technology is suitable for the un-sewered parts of Kisumu.

Depending on the extent of LTAP investment in the informal area, there may be significant

potential for condominium sewers in this EIB project.

An idea for the condominium sewers could be to piggyback onto the existing "master operator" water management model. Under this model, bulk meters are installed at the mains, which run past Nyalenda, and CBOs (or individuals) collect revenue from their customers inside the informal area.

The master operator lines run in the approximate direction that a condominium sewer might run (perpendicularly away from the road), and they form a potentially symbiotic relationship. Customers paying for water (or with a water connection) are both wealthier than the indigent and relatively high consumers of water. They are the ideal customers to target for network sewerage. Communal clothes washing (or car washing) facilities, which consume a lot of water that can pool and stagnate when done haphazardly, could be constructed on or near the network, also operated by the master operator (see communal facilities below). The sewer tariffs can be collected through the water rate (as they currently are) and remitted to the master operator, who will be responsible for keeping the line clear of blockages and penalising or sanctioning customers who reject unsuitable waste (for example, by inspecting their connection grease traps in the event of a blockage to trace the culprit).
Should LVSWSB become the asset owner for the condominium sewers, some part of the tariff should still be remitted to KIWASCO (and thence to LVSWSB) to repay the loan and cover capital maintenance. Note that the master operators could also be the asset owners responsible for capital maintenance However given it is unlikely they will take on the loan (particularly with their 1-year rolling contracts), the asset will probably be on LVSWSB"s books until the loan is paid off by the master operators through the tariffs collected (at which point the asset could be transferred).
In Atkins" experience, as informal settlements become more established, wealthier, and denser, the inhabitants get tired of walking through their own excrement and build their own sewers. These can be very variable, blocking and collapsing often and discharging where the money ran out (or just out of „nose shot"). A better approach under this project would be to anticipate this and provide a reasonable solution.

Source: Atkins: Draft Project Formulation Report Kisumu, September 2011

Figure 4-3 – Slum restructuring & densification

4.3.1.2 Informal settlements

The Plan describes a two pronged approach to restructuring the slum belt circling the city from the South of Milimani to the Eastern tip of Obunga:

- improve mobility within the neighbourhood and reintegration into the formal city through the creation of a *formalized road network* based on identified desire paths and allowing accessibility and connection with the "formal city"
- reach a desired *higher population & built up density*, and *improve housing standards* via the introduction of a range of plot and housing typologies able to accommodate mixed uses and accessible to a range of households according to their means.

Source: Egis: Kisumu Water Supply and Sanitation Project, Technical and Management Support to LVSWSB, Final Project Preparation Report, September 2015.

4 Comparative Analysis

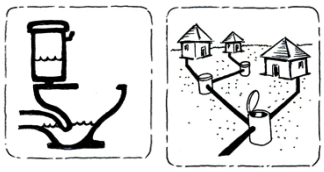
4.1 Design of Proposed HPI

The design parameters are presented in Appendix 3: Design Criteria. The population to be served is presented in Table 7 (2016 population).

Table 7: Population for Manyatta A, Manyatta B & Obunga Catchment, Kisumu City

AREA	POPULATION	HOUSEHOLDS
Manyatta A	55,142	11,273
Manyatta B	32,108	7,027
Obunga	31,360	6,887
TOTAL	**118,610**	**25,187**

Condominium sewerage



Condominium sewerage, also indicated as Shallow Sewers or Simplified Sewers, describe a sewerage network that is constructed using smaller diameter pipes laid at a shallower depth and at a flatter gradient than conventional sewers. The condominium sewerage allows for a more flexible design associated with lower costs and a higher number of connected households. The design on shallow sewers is described in two design manuals:

- Mara, Duncan (2001), Andrew Sleigh and Kevin Tayler: PC--based Simplified Sewer Design, School of Civil Engineering University of Leeds and GHK Research & Training, London;
- Bakalia, Alexander (1994), Albert Wright, Richard Otis and Jose de Azevedo Netto, Simplified Sewerage, Design Guidelines, UNDP/World Bank.

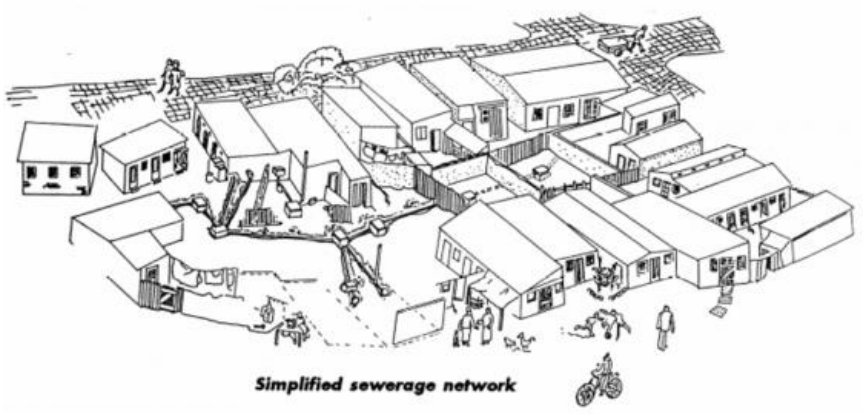


Figure 30: Shallow Sewerage (SSWM, 2012)

Table 8: Advantages and Disadvantages Condominium Sewerage

Advantages	Disadvantages
• Can be built and repaired with locally available materials; • Construction can provide short-term employment to local labourers; • Capital costs are approximately 30% lower than for conventional gravity sewers; • Can be extended as a community changes and / or grows.	• Requires enough water for flushing; • Requires expert design and construction supervision; • Requires repairs and removals of blockages more frequently than a conventional gravity sewer.

4.2 Technical Design of Proposed HPI

Self-cleansing flows have been considered in the sizing of the sewer pipes.

Table 9: Sizing for Varying Connections

AREA	PIPE DIAMETER (mm)	MIN SLOPE (%)	LENGTH (m)
Manyatta A	250	0.9	17,795
Manyatta B	450	0.5	4,700
	250	0.5	15,281
Obunga	450	0.8	1,630
	300	1.0	883
	250	0.6	10,292

Table 10: Ablution Blocks

Area	2009 statistics	Population 2009	Population Projection 2016	House hold	Area KM2	Target Households (90%)	Ablution blocks
Manyatta A		48,004	55,142	12,525	2.40	11,273	1,127
Manyatta B		27,952	32,108	7,808	2.50	7,027	703
Obunga	Nyawita	14,747	16,940	4,099	1.30	3,689	369
	Kanyakwar	12,554	14,421	3,553	6.60	3,198	320
Total		**103,257**	**118,610**	**27,985**	**12.80**	**25,187**	**2,519**

4.3 Cost Estimates of Works

Table 11: Cost Estimate HPI

Bill of Quantity					
Bill No.	**Item**	**Quantity**	**Unit**	**Rate**	**Amount**
	Manyatta A Cost Estimate				
A1	250mm UPVC Pipes, Supply and fix	17,795	m	€ 113	€ 2,011,547
A2	1200mm Manholes Reinforced Concrete, average depth of 3m	48	no	€ 2,235	€ 107,269
A3	900mm Manholes Reinforced Concrete, average depth of 2m	445	no	€ 1,191	€ 530,129
A4	600x600mm Inspection Chambers masonry walled, average depth 1.5m	1,253	no	€ 217	€ 272,390
A5	Ablution Blocks	1,128	no	€ 1,500	€ 1,692,000
A6	Sub - Total 1				€ 4,613,334
A7	Preliminaries and General				€ 461,333

Bill of Quantity					
Bill No.	**Item**	**Quantity**	**Unit**	**Rate**	**Amount**
A8	**Total Manyatta A Direct Investment**				**€ 5,074,668**
A9	Capacity building				€ 50,747
A10	Construction supervision				€ 507,466.79
A11	Project Management Unit				€ 50,747
A12	**Total Manyatta A at Project Completion**				**€ 5,683,628**
	Manyatta B Cost Estimate				
B1	450mm PCC pipes, supply and fix	4,700	m	€ 217	€ 1,018,584
B2	250[6]mm UPVC pipes, supply and fix	15,281	m	€ 113	€ 1,727,364
B3	1200mm manholes reinforced concrete, average depth of 3m	110	no	€ 2,235	€ 245,826
B4	900mm manholes reinforced concrete, average depth of 2m	500	no	€ 1,191	€ 595,650
B5	600x600mm inspection chambers masonry walled, average depth 1.5m[7]	781	no	€ 217	€ 169,782
B6	Ablution Blocks	703	no	€ 1,500.00	€ 1,054,500
B7	Sub - Total 1				€ 3,793,122
B8	Preliminaries and General				€ 379,312
B9	**Total Manyatta B Direct Investment**				**€ 4,172,434**
B10	Capacity building				€ 41,724
B11	Construction supervision				€ 417,243.38
B12	Project Management Unit				€ 41,724
B13	**Total Manyatta B at Project Completion**				**€ 4,673,126**
	Obunga Cost Estimate				
C1	450mm UPC Pipes, Supply and fix	1630	m	€ 217	€ 353,254
C1	300mm UPC Pipes, Supply and fix	883	m	€ 157	€ 138,631
C2	250mm UPVC Pipes, Supply and fix	10,292	m	€ 113	€ 1,163,408
C3	1200mm manholes reinforced concrete, average depth of 3m	20	nr	€ 2,235	€ 44,696
C4	900mm manholes reinforced concrete, average depth of 2m	320	nr	€ 1,191	€ 381,216
C5	600x600mm inspection chambers masonry walled, average depth 1.5m	770	nr	€ 217	€ 167,390
C6	Ablution Blocks	690	nr	€ 1,500.00	€ 1,035,000
C7	Sub - Total 1				€ 3,283,594
C8	Preliminaries and General				€ 328,359
C9	**Total Obunga Direct Investment**				**€ 3,611,954**

[6] Smaller pipes avoided due to maintenance and Service Provider Policy on minimum pipe

[7] Masonry chambers to facilitate the condominium sewer network

Bill of Quantity					
Bill No.	**Item**	**Quantity**	**Unit**	**Rate**	**Amount**
C10	Capacity building				€ 36,120
C11	Construction supervision				€ 361,195.36
C12	Project Management Unit				€ 36,120
C13	**Total Obunga at Project Completion**				**€ 4,045,388**
	Grand Total Improved Sanitation (rounded € mln.)				**€ 14.40**
	Augmentation Water Supply (rounded € mln.)				**€ 1.66**
	Grand Total (rounded € mln.)				***€ 16.06***

4.4 Alternative Scenarios

4.4.1 Management by KIWASCO instead of via DMM

In Kisumu, KIWASCO has some challenges with the MOs:

- The MO's work under a work contract that is quarterly appraised and renewed annually. However, day to day operation is executed independently and may not adhere to the rules and regulations[8];
- MO's charge 'informally' twice the tariff they are supposed to charge.

Hence, instead of working via MO's, KIWASCO could service the facilities directly. As far as investment costs are concerned this will not make any difference. KIWASCO's penetration into the poor settlements has proven to be challenging in the past and might not be a serious alternative. However, as indicated in Atkins report, there are a number of improvements required, see text box below. In 2016 these observations of 2011 still seem to be valid.

KIWASCO likes this model, which vastly simplifies their revenue collection and transfers a substantial amount of risk to the master operators. The contracts between the master operators and KIWASCO are very inadequate. The level of detail is inappropriate and appears to be copied from other contracts by third parties, without consideration of what is achievable. For example, they assume that the master operators will report on the number of written complaints responded to within two days, and that KIWASCO will unfailingly supply water 24 hours per day. Therefore the relationship is in the informal domain, rather than in a contractual one by default. That aside, the master operator model seems to work despite the risks their businesses are exposed to in the event of a leak or theft. These problems could be quite easily solved by simplifying the contracts to one page of relevant information and changing the bulk or retail price to better reflect the risk.

Source: Atkins: Draft Project Formulation Report Kisumu, September 2011

4.4.2 Decentralized Treatment Instead of Centralized Treatment Management by KIWASCO Instead of via DMM

In line with Atkins' recommendations, the project note prepared by LVSWSB (Appendix 1: Proposal LVSWSB), suggests to apply decentralized wastewater treatment such as anaerobic digestion. A benefit of this approach could be the valorisation of wastewater by producing biogas. However, we decided not to follow this suggestion for the following reasons:

- There have been important investments in centralized wastewater treatment plants. Both plants run at a very low capacity. Hence, it seems logic to use existing treatment capacity instead of adding capacity;
- The rather poor state of recently upgraded centralized WWTP at Kisat and Nyalenda (with skilled staff) shows that O&M of WWTPs is a challenge that cannot be underestimated. It is not likely that decentralized WWTPs will be operated and maintained in a proper way.

[8] Source: Atkins

4.4.3 Application of non-sewered Options: Sanergy[9] or Sanivation

The introduction of non-sewered options is based on the following considerations:

- In the last 5 years there has hardly been any progress in improving the sanitary conditions in the informal settlements in Kisumu despite the plans and reports available;
- The current project has a budget for € 30 mln for 4 HPIs. It is not very likely that 100% of the € 16 million investment needed for Kisumu can be released. Hence, many people would continue to live in insanitary conditions if solutions are selected that require an investment per household of €635;
- Sewerage reduces the possibility to valorise faecal sludge and wastewater.

Non-sewerage alternatives that are being implemented successfully in Kenya are Sanergy in Nairobi and Sanivation in Naivasha.

Sanergy is a non-piped sanitation service model developed for the informal settlements of Nairobi. It is based on servicing individual households and illustrated in Figure 31.

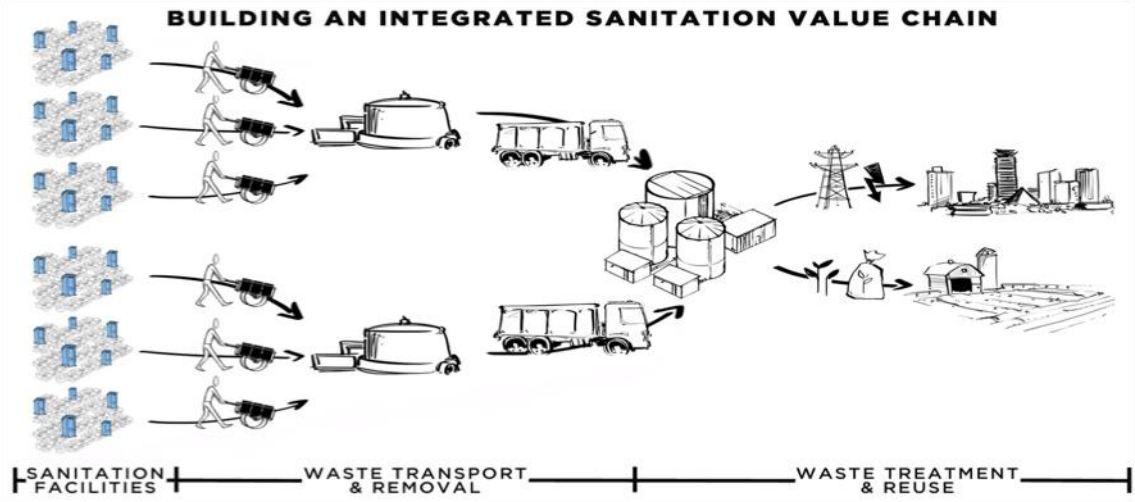


Figure 31: Sanitation Chain Sanergy

Fresh Life Toilets. Sanergy designs and manufactures low-cost, high-quality sanitation facilities. These Fresh Life Toilets (FLTs) are pre-fabricated at the local workshop.

The FLT features qualities users value most:

- Hygiene: FLTs are made of high-quality materials that are easy to keep clean and maintain;
- Accessibility: FLTs have a small footprint that enables us to install them close to homes;
- Affordability: FLTs are cost-effective and include essential features like hand-washing facilities.

Franchise. Through informal settlements, Sanergy builds a network of Fresh Life Operators (FLO) – local residents who purchase and operate the hygienic sanitation facilities. The operators become franchise partners: Sanergy provides its FLT, training, access to financing, ongoing operational and marketing support, and a daily waste collection service. The FLO generates local demand and ensures that the FLT is kept clean. Sanergy has three distribution models for the Fresh Life Toilets in the communities:

- Commercial: Pay-per-use toilets run by local entrepreneurs;
- Residential: Toilets in residential plots, offering tenants secure 24-hour access to hygienic sanitation;

[9] Source: www.saner.gy accessed 19 May 2016.

- Community Institution: Toilets in schools, churches, and clinics to reach the most vulnerable populations.

Collect. Sanergy collects the waste on a daily basis. The Fresh Life Frontline is trained and properly equipped to remove the filled cartridges and replace them with clean empty cartridges. The waste is safely removed from the community by wheelbarrow, handcarts, and/or truck. The wheelbarrows and handcarts ensure that we can install FLTs deep in informal settlements where there are only narrow, unpaved roads as access points.

Convert. Sanergy converts the waste at a centralized facility into useful end-products such as organic fertilizer, insect-based animal feed, and renewable energy. To produce the fertilizer, Sanergy co-composts the waste with sawdust, other carbon sources and effective micro-organisms, which eliminates pathogens.
Then, Sanergy lets the compost mature in windrows. Once ready, Sanergy tests every batch of fertilizer by third parties to ensure compliance with World Health Organization standards. To produce the insect-based animal feed, Sanergy has a colony of Black Solider Flies, whose larvae consume organic waste, removing the pathogens and converting the waste into protein. Boiled and sun-dried to eliminate any pathogens, the larvae make a sustainably produced, nutrient-rich protein input for animal feed. Sanergy also finds ways to re-use the urine and capture the biogas released by the waste. 100% of the waste is safely treated.

Transfer. In East Africa, there is high demand for Sanergy's products. 1.2 million tons of synthetic fertilizer is imported every year, leading to high transportation and tariff costs, which is ultimately borne by farmers. In fact the price of fertilizer is so high that farmers can only afford to purchase 9 kg/hectare of fertilizer compared to the 206 kg/hectare used in the industrialized world. Sanergy sells organic fertilizer to a variety of Kenyan farms. Most animal feed in East Africa is made with Omena, or fishmeal, as its main source of animal protein. Harvested from Lake Victoria, Omena is not sustainable and is delivered to feed millers mixed in with a lot of other materials, including sand, shells, and other fish. The low quality of Omena results in poor animal growth. Sanergy's protein input provides a consistent quality alternative to Omena.

Clean Team Ghana. The model of the Clean Team is presented in Figure 32.

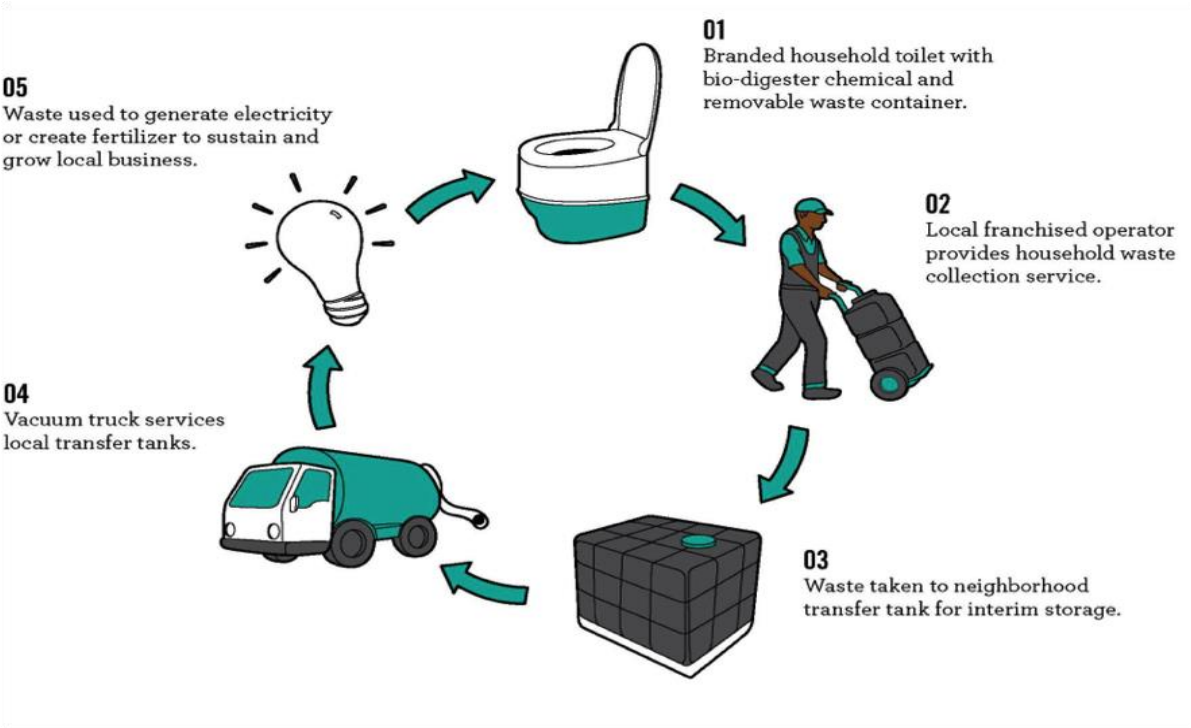


Figure 32: Clean Team Model

The toilets cost between $50-60 USD to build. Currently, Clean Team will deliver a portable toilet to a house for free, but charges a weekly fee to collect the waste. Households can opt for two to four waste collections a week (two collections for $10 USD/month, 3 for $15 USD/month and 4 for $20 USD/month). The waste is transported to a processing facility, and then taken to the municipal treatment site. In the future, the company plans to convert the waste into energy and organic fertilizer to sell to commercial farms in the region.

Sanivation in Naivasha provides also in-house toilets (Figure 33 and Figure 34), collects the buckets twice a week and produces briquettes (Figure 35) that are sold.

Figure 33: Sanitation Toilet (1) ***Figure 34: Urine Diversion Dry Toilet (UDDT)***

Figure 35: Briquettes for Sale

4.5 Comparison of Proposed HPI with Alternative Scenarios

In Table 12 we compare the prosed HPI 'condominium sewerage' with the alternative scenario: 'non-sewered sanitation service model' option.

Table 12: Comparison Proposed HPI with Alternative Scenario

Criterion	Condominium sewerage	Score	Non-sewered sanitation service model	Score
Investment cost for 25,000 hh	€ 16 mln.	- -	~ € 1.25 mln. (25,000 toilets) ~ € 0.75 mln. (collection system and treatment at Kisat)	+ +
O&M costs 25,000 households	5 % of € 635/hh, say € 2.5 per hh per month (excluding piped water supply bill)	+	~ € 8 /hh/month	- -
Valorisation of faecal sludge	nil	- -	Compost, fuel, fodder	+ +
Easy of operation / attractiveness	'flush and forget', very easy	+ +	Access at night, but always something to take care of	- -
Socio-economic aspects	Nil	0	Provides job opportunities and income	+ +
Political support	Positive as long as donors pay	+ +	Doubtful	-
Total score		***+1***		***+1***

4.6 Conclusion of the Analysis

We recommend implementing two pilots:

- Condominium sewerage in Manyatta A for 25% of the target population: 2,750 hh (estimated costs: € 4 mln)

- Non-sewered sanitation service model in Obunga for 7,000 hh (estimated costs: € 0.6 mln)

5 Project Implementation

It is envisaged that the implementation programme for the project will take approximately 4 years. Detailed design for the project will take 1 year with the construction and defect notification period taking 3 years.

Programme of the Selected Project Development

Implementation Programme
The construction implementation programme envisaged is as follows:

1. Request for prequalification
2. Tendering and selection of contractors
3. Contract award
4. Construction
5. Defects notification period

The implementation works will require a consultancy supervision and programme of the consultancy services will consist of:

1. Request for proposal
2. Selection of consultant
3. Award and signature
4. Construction supervision
5. Defects notification period.

Table 13: Implementation Schedule for Consultancy Supervision and Construction

	Year 1											
Acitivity	1	2	3	4	5	6	7	8	9	10	11	12
Request for prequalification	X											
Tendering and selection		X	X									
Request for proposal				X								
selection of the consultant					X	X	X					
Award and Signature for the consultant								X				
Contract Award for the contractor								X				
Construction and construction supervision										X	X	X
Defect Liablity period												

Table 14: Construction Supervision Continued

	Year 2											
Acitivity	13	14	15	16	17	18	19	20	21	22	23	24
Construction and construction supervision	X	X	X	X	X	X	X	X	X	X	X	X
Defect Liablity period												

Table 15: Construction Supervision Continued

	Year 3											
Acitivity	25	26	27	28	29	30	31	32	33	34	35	36
Construction and construction supervision	X	X	X	X	X	X	X	X	X	X		
Defect Liablity period											X	X

Table 16: Defects Liability Period

	Year 4										
Acitivity	37	38	39	40	41	42	43	44	45	46	47
Construction and construction supervision											
Defect Liablity period	X	X	X	X	X	X	X	X	X	X	X

6 Operation and Maintenance

6.1 Capacity Building

As noted during the study, KWASCO and especially the MOs are facing a number of operational challenges. These should be tackled urgently through capacity building to enable the proposed project to have its intended impact.

6.2 Proposed Capacity Building Measures in Operation and Maintenance of the Facilities

The O&M set up for the existing scheme and the proposed expansion will be improved and rationalized in order to ensure continuity of wastewater system coverage in the whole project area.

The O&M teams will ensure the following:

- Maintain a reliable water supply and sewerage system;
- Ensure equitable distribution of water supply and sewerage collection system to consumers;
- Provide an efficient service to all the consumers by prompt attendance to complainants;
- Ensure a sound revenue base;
- Regularly maintain various components of the scheme in order to avoid continuous deterioration and subsequent high rehabilitation costs.

For the above O&M goals to be satisfactorily met, the following improvements will be carried out:

- O&M base will be established;
- Provision of adequate and reliable transport for the maintenance staffs;
- Provision of proper tools and equipment for maintenance purposes;
- Provision of adequate and experienced staff to carry out the O&M duties.

6.3 Improvement in Operation and Maintenance

This following improvements in operational measures and maintenance procedures are required if the new and improved facilities are to operate effectively and at full capacity throughout their lifetimes:

Develop system inventory and asset management plans. The inventory should include major equipment, piping and treatment systems. Available data such as age, expected useful life, condition, service history, and nameplate data should be included. The financial value of assets and list of depreciated assets should be included. Develop or use available standard forms, or purchase and customize available software (recommended) to create inventories and convert to an asset management plan by prioritizing assets and estimating future needs and costs. Priority should be given to critical infrastructure at or past the end of its useful life. Develop a preventative maintenance plan and maintenance tracking system, including all inventory components.

Prepare O&M manuals for all facilities including layout drawings and regular maintenance requirements. Obtain manufacturer's manuals for all existing equipment; incorporate recommended maintenance into preventative maintenance plan.

Review water and wastewater staffing levels and conduct staff rationalization study by an external Human Resources consultant. Include considerations for organizational chart development, task analysis, determination of staffing requirements, creation of job descriptions, and implementation plan for staffing changes.

6.4 Provision of Operation and Maintenance Tools and Facilities

In order to provide efficient and effective O&M of the wastewater facilities, the following basic tools and equipment will need to be provided by KIWASCO to the MOs:

- Provision of vehicles: 1no. pick up (double cabins) 4x4 WD and 2 no. pick up 2WD;
- One lorry for transporting repair materials and the chemicals;
- One sewer flushing truck;
- Provision of motor bikes: 3 No;
- Provision of tools and equipment for O&M work, 4 no. sets;
- Provision of blockage detection equipment for assessment and detection of blockages along the sewer lines;
- A JCB excavator for necessary extensions and repairs. – 1 No;
- Provision of 1 No. division office including IT and communication equipment such as radio call and furniture and well manned by competent staff;
- Provision of one exhauster;
- Establishing transport department that will manage the proposed tools and facilities.

The consultant strongly proposes that the management of KIWASCO creates a division for O&M of the wastewater facilities to support the MOs in the Informal settlements.

6.5 Training of O&M Staff

Establish a regular staff training programme, including training of staff on performance indicators and technical, financial, and managerial skills for both WSP and WSB staff. Further organize for on-the-job training of the operators on the best practices on plant process control. Training of WSP and WSBs staff on preventive maintenance will also be conducted. Exchange programmes with other local WSBs/WSPs and international organizations in the water and sewerage sector to expose staff to sector best practices have also been contemplated. Training and capacity building is recommended, including specific training courses, targeted workshops, and study tours for the Board of Directors, Senior Management and staff of KIWASCO.

6.6 Cost Estimate for Capacity Building Proposals

It is estimated that the capacity building costs **€ 125,000.**

7 Legal and Institutional Analysis

7.1 The Kisumu Setting

Kisumu, the third largest city in Kenya, is the capital of Kisumu County. It has developed progressively from a railways terminus and inland port in 1901, to become the leading commercial, trading, industrial, communication and administrative centre in the Lake Victoria basin, an area that traverses the counties of Migori, Homabay, Kisumu, Siaya and Busia. Kisumu also serves as an important communication and trading confluence for the Great Lakes region i.e. Tanzania, Uganda, Rwanda and Burundi.

Kisumu City hosts a population of 409,928 people[10] based on the latest 2009 Kenya Census. The majority of these people is engaged in micro businesses in the informal sector and some are unemployed with no sustained sources of income.

Poverty levels in Kisumu City, Kisumu District and Nyanza province are quite high. The mean poverty incidence for Kisumu City in 2005 was about 62 percent, compared to 53 percent nationally[11]. In the below figure, the poverty incidence for Kisumu city is given.

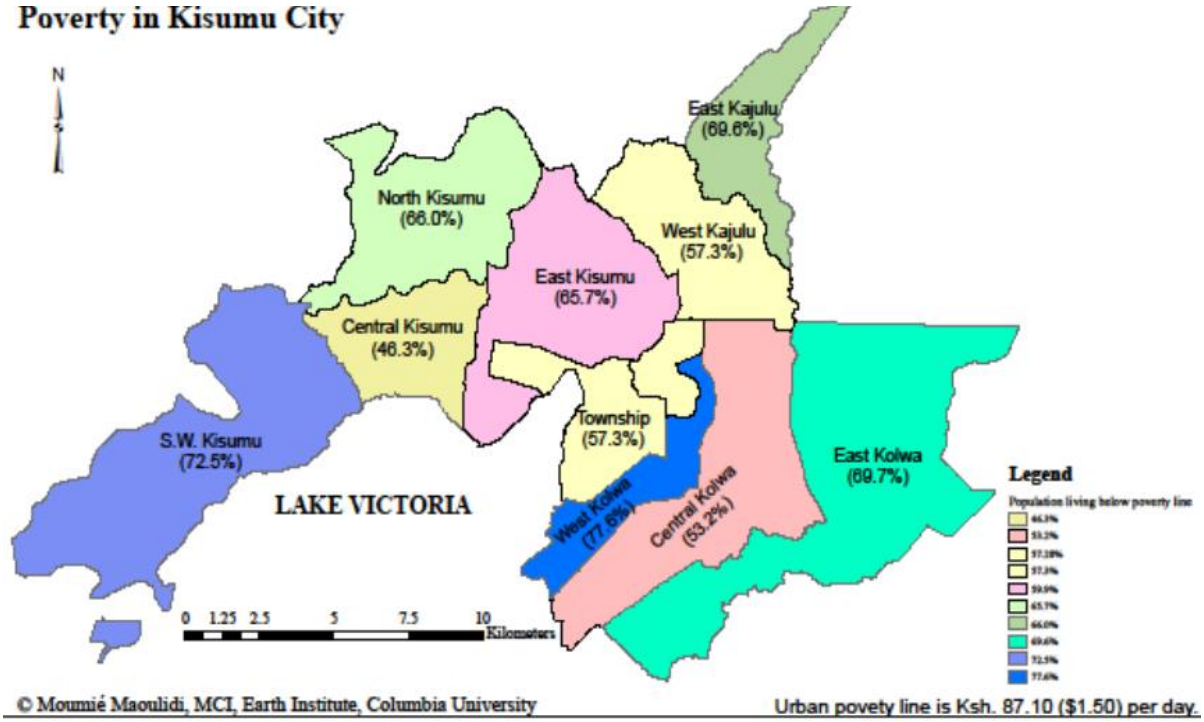


Figure 36: Incidence of Poverty in Kisumu City and Kisumu District (*Source: Earth Institute, Columbia University)*

In Kisumu, the main economic activities are fishing and farming.
The Municipality can be zoned into high-income and middle-income residential areas that are adequately served by the Council and its affiliate companies like KIWASCO. Then there is the

[10] 2009 Census Vol 1 Table 3 Rural and Urban Population Retrieved on 22 January 2014.

[11] KISUMU MILLENNIUM DEVELOPMENT GOALS MULTI-SECTOR HOUSEHOLD SURVEY , Millennium Cities Initiative, Earth Institute, Columbia University, 2014

low income and informal settlements that are common in Manyatta and Nyalenda, Obunga and Bandani.
There has been a dramatic increase in rural-urban migration in the recent years. Most of the people migrating to the urban areas do not have adequate formal education which would increase chances for economically gainful employment. As a result, Kisumu has low levels of formal employment – and even the majority of those in formal employment often are not adequately qualified or suited for the jobs they hold. This leads to exponential growth in informal settlements.

7.2 The Sector

The Water Act of 2002 [12] established the Water Boards as parastatals under the Ministry of Water and Irrigation (MWI). The Water Boards were established to develop infrastructure for water and sanitation. Currently the Minister has constituted 8 Water Boards. A Water Services Board shall, as a licensee, be responsible for the efficient and economical provision of water services authorized by the licenser. Main responsibilities are[13]:

- Developing water and sewer facilities, investment planning and implementation;
- Rehabilitation and replacement of infrastructure;
- Applying regulations on water services and tariffs;
- Procuring and leasing water and sewerage facilities;
- Contracting Water Service Providers (WSPs).

The main responsibilities of the Water Services Regulatory Board (WASREB) are:

- Regulation and monitoring of service provision (Water Services Boards and Providers);
- Issuing of licenses to Water Services Boards to provide water supply and sewerage services;
- Setting standards for provision of water services;
- Developing guidelines for fixing of tariffs for the provision of water services;
- Developing model performance agreements for use between licensees and water license providers;
- Developing guidelines and provide advice on the cost-effective and efficient management and operation of water service providers;
- Monitoring the operation of agreements between water services boards and water service providers and to take appropriate action to improve their effectiveness;
- Promoting water conservation and demand management measures.

Besides, there is a Water Services Trust Fund (WSTF) for financing provision of water and sanitation to disadvantaged groups (pro-poor) as water poverty fund.

In Figure 37, the different players of the water and sanitation sector are depicted.

[12] There is a new Water Act (2015) but this is not yet effective and is being discussed in Parliament

[13] Water Act 2002 and Kiwasco's strategic Plan 2012 – 2016

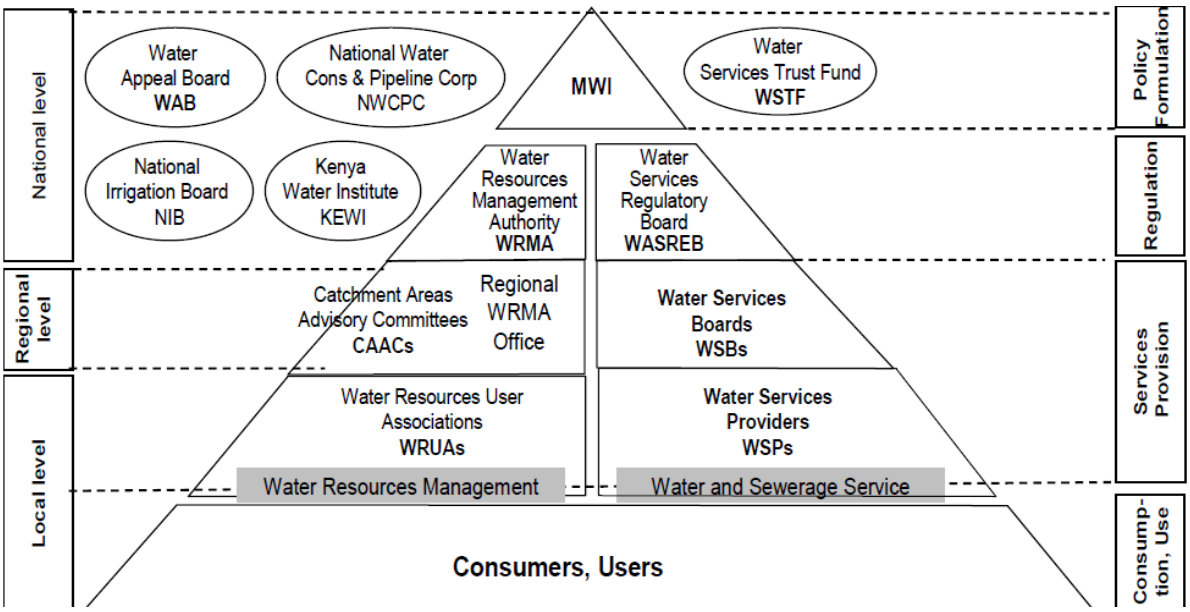


Figure 37: Institutional Framework under Water Act 2002 *(Source: KIWASCO's strategic Plan 2012 – 2016)*

7.3 The Implementing Agency – KIWASCO

Kisumu Water and Sewerage Company (KIWASCO) was founded in 2001 and registered under CAP 46 of the Laws of Kenya as a subsidiary company of the Municipal Council of Kisumu (MCK).[14] It began its operations on 1st July 2003. KIWASCO was established through the reforms that took place in the water sector nationally and based on the decision to privatize essential services. It was established through transformation of the water and sewerage department of the Municipal Council of Kisumu.

For Kisumu County the responsible Water Board is Lake Victoria South Water Board. This implies that the ownership of the assets is to the Water Board. KIWASCO has to pay a lease fee for using the assets. The level is determined by the Regulatory Board (Art 60 of Water Act).

Following the Water Act of 2002, KIWASCO was established as an Ltd Company under the Company Act (2003). This implies that KIWASCO operates as a commercial company, with full independence. However, tariffs have to be approved by the Water Services Regulatory Board (WASREB).

The City Council is owner of KIWASCO, but administratively KIWASCO falls under the Water Board.

The core functions of KIWASCO include (but are not limited to) the following:

- Abstraction, treatment, transmission and distribution of water and the collection, transmission, treatment and disposal of sewage to the prescribed service and quality standards and the handling and disposal of sludge and screenings originating from such processes;
- Maintenance and repair of the assets;
- Development and management of programmes for the advancement of the skills and competencies of persons employed within the company;
- Establishment of mechanisms for promoting customer relations including the development of agreements with customers and the publication of each code as provided for in the agreements;
- Provision and replacement of operating equipment;
- Responsibilities for connections.

[14] Kiwasco's strategic Plan 2012 - 2016

KIWASCO's activities are currently confined to the city of Kisumu, but its service area may be extended to other parts of the County in the future. In the second strategic plan, of 2012 – 2016, KIWASCO identified its major challenges. These were drafted in 2011 but they are still valid:

- Key among these are collection efficiency which has remained below target because of lack of payments from government and public bodies on accounts which are disconnected and are not returned to supply accounts, delayed and intermittent payment trends by government accounts, lack of payments from accounts billed on sewer only - not connected to water. Currently, collection rate is some 92%, but it has to increase further;
- Inherited debts and customer's unwillingness to pay. The debt portfolio which has grown due to the reasons mentioned above and un-honoured promissory notes, continues to pose a challenge to the company. According to the Head of Finance, Mr Nicolas Moseti, debts are currently KES 267 mln. Half of the debts are from before 2002 when it was still part of the Municipal Council and involve debts from institutions. They try to settle these debts, off set them against other outstanding debts. According to the Head of Finance large-scale write-off is not possible;
- Inactive accounts continue to grow as a result of low disconnections to reconnections ratio. Less than half of the disconnected customers turn up to pay for reconnection within the cycle. The issue of petty corruption to look the other way or forestall the disconnections also adds onto the challenges that KIWASCO is facing;
- Conversion of informal settlements into DMMs (Delegated Management Model) has been slow due to lack of global funding especially in places like Obunga. Currently, there are 33 DMMs, but this number needs to increase further;
- While lauding the current customer responsiveness in comparison with years past, customer complaints resolution and action is sometimes hampered by lack of complete records;
- Total operation costs have gone up as a result of high costs of electricity and chemicals. It is hoped that KIWASCO will explore innovative ways of absorbing this rising cost without passing it the end consumer;
- Difficulties in attracting high skills levels in the county;
- Reduction of NRW. Currently the NRW is some 43% which is compared to international standards[15] very high;
- Receding lake levels and deteriorating quality of the lake water;
- Rapid growth in informal settlements due to rural urban migration and poor planning.

In the table below, SWOT analysis of KIWASCO is given[16].

Table 17: SWOT Analysis

Strengths	**Weaknesses**
Availability and proximity of raw materials	Dilapidated infrastructure which leads to constant bursts and leaks
Ready market for our product i.e. water and sewerage services to the city	Lack of commercial orientation amongst staff
Strong and capable leadership starting with the Board of Directors and effective and professional senior management team with long experience	Shortage of skilled workforce at the lower cadre
Established effective operational structures and systems in infrastructure management, procurement, financial management, human resources and commercial services	Slow pace of extension of water and sewerage network
Robust and organized system of supplying water in informal settlements	Inadequate facilities to respond to repairs and replacement of the already old pipe network
Good system for revenue collection and billing	High water loss leading to high NRW
Opportunities	**Threats**
High potential for unconnected and new	Increased cost of production due to frequent

[15] International benchmark is 25%

[16] Kiwasco's strategic Plan 2012 - 2016

customers	increase in cost of electricity and chemicals
Upgrading of Kisumu airport to International status, improved road networks and Kisumu being the Headquarters for LVBC	Water theft due to illegal connections
Willing partners to engage in improving access to water and sanitation services	Lake & River pollution from industrial and human effluent
Benchmarking and knowledge sharing with other utilities in Kenya	Competition from other small water service provider's
Energy deficiency in the country presents opportunities for power co-generation from sewage	Environmental degradation threatening water sources
Permanent and cheaply available water source in Lake Victoria	Risk of clustering with other weaker utilities under the county arrangement in the new Constitution
On-going water reforms	Global warming, receding lake levels, lake weeds
A growing middle class means reliability in payment of water consumed	Rural to urban migration that will accelerate growth of informal settlement
	Political interference in governance and management
	Escalating inflation hampers business/reduces purchasing power

In line with the vision and mission of KIWASCO and to deal with these challenges, the following strategic objectives are indicated:

1. Ensure operational efficiency and institutional strengthening;
2. Network expansion and renewal;
3. Customer and key stakeholder satisfaction;
4. Grow and expand revenue base;
5. Improve services to the poor and the vulnerable;
6. Enhance corporate image;
7. To achieve operational financial sustainability;
8. Attract and retain the best talent/employer of choice;
9. Customer focused staff and results oriented culture.

The strategy or follow up reports do not provide any information on the performance of these objectives.

In Figure 38, the high-level organization structure is given.

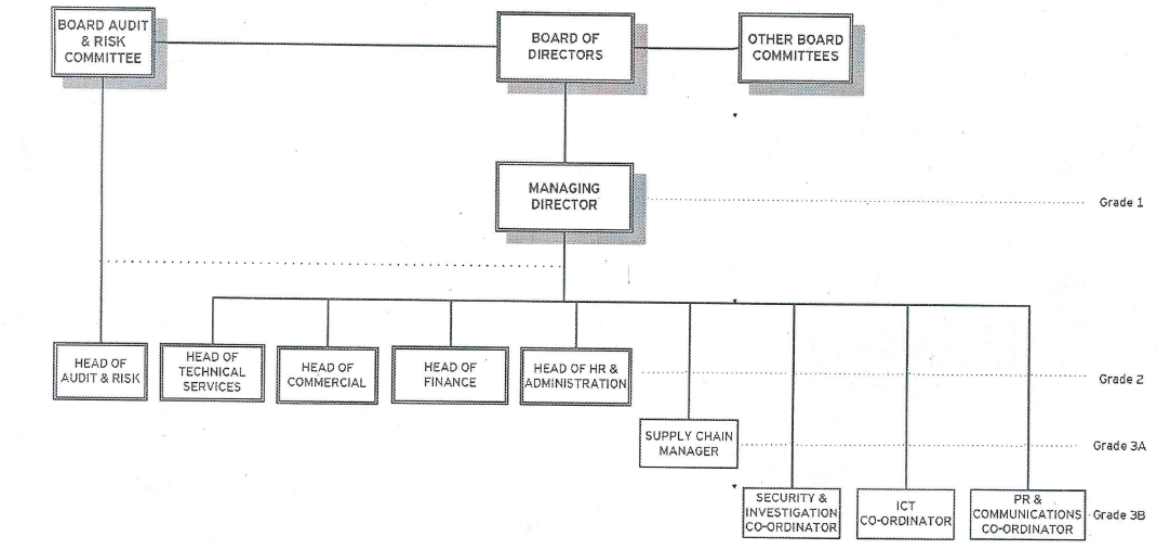


Figure 38 Organisation Structure KIWASCO

KIWASCO employs about 250 staff, 30 of them work in the wastewater department.[17]
KIWASCO has been profitable in the last three years. In FY15, profit was KES 7,897,512, compared to KES 525,377 in FY14. In FY13, the profit was KES 2,012,566.

7.4 Sustainability

We consider KIWASCO capable of managing the project and doing the project implementation for the following reasons:

- KIWASCO is a financially viable organization, which operates on a profitable basis. Collection rate is 92-93%, but the NRW is too high: 43%. Lowering the water losses will have to be a key priority in ascertain also future financial sustainability;
- The fact that also AFD and EIB are providing loans is a proof that KIWASCO is financially stable and capable of repaying the loans. It must be noted, however, that the AFD loan will severely add to the financial burden of KIWASCO and that the proposed tariff increase is a precondition for KIWASCO to be able to remain financially sound;
- However, there are many future challenges, such as to the low coverage ratio of both the water and sewerage network in the city and the high NRW-level;
- Especially the fast growth of the population in the informal settlements and the low rate of connections in the informal settlement is a major issue. DMMs are being established via the CBOs, both for water and sewerage but this delegated management model has to be extended further;
- Direct interventions by KIWASCO in the informal settlements would not be a good option, also because they lack the knowledge and experience of the management of such small systems. Therefore, a DMM model is applied for the HPI- investments;
- They are financially sound; their cost-recovery level is over 100% and their collection ratio is also high (in FY12 it was 98%[18]);
- They have experience in operating and maintaining sewerage networks and WWTPs;
- They know how to manage large projects that are financed by international financing institutions and development donors;
- They have capable staff operating WW systems.

7.5 Tariff Setting

Last tariff increase was approved in 2012. Presently they have requested a tariff increase to deal with the loan repayments of the AFD loan. For sewerage, there is a surcharge to the water bill of 20%.

[17] Joseph Obunde, Wastewater engineer KIWASCO

[18] Corporate Plan JULY 01, 2012 - JUNE 30, 2015

8 Financial and Economic Analysis

8.1 Assumptions

The following tables present the assumptions of the Financial and Economic Analysis

Table 18 Assumptions

Description	Value	Unit
Rent 10-12 m² house	4,000	KES / month
Approximate expenditure on rent as %age of household income	0.30	%, 0 - 1
Estimate of income based on rent costs	13,333.33	KES / month
Majority of Manyatta residents earn less than 30,000KES/month	30,000	KES / month
Minimum wage labourer (Kisumu, Mombasa, Nairobi)	10,955	KES / month
Real income growth per year	0.02	%, 0 - 1
Household income to be applied in model	30,000	KES / month
Water use		
Ablution blocks - Manyatta A	1 128	# ablution blocks
Ablution blocks - Manyatta B	703	# ablution blocks
Ablution blocks - Obunga	690	# ablution blocks
Households per ablution block	10	# households
Household size	5	people per household
Water use per capita	70	litres / capita / day
Tariffs		
Sensitivity: increase in water + sewerage tariff	1	Factor
Water tariff, fixed fee for first 6 m³ per month	180	KES
Water tariff per m³, >7 m³ per month	35	KES/m³
Sewerage tariff, as % of water bill	1.00	%, 0 - 1
Fee collection rate	0.90	

8.2 Result

Figure 39 presents the year-on-year cash flow of the project under operations (before financing

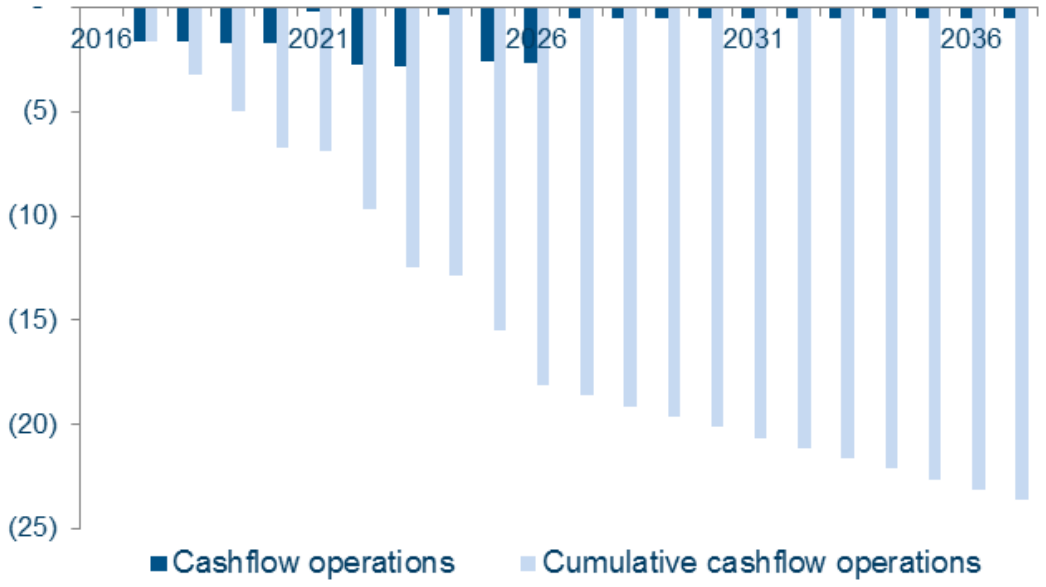


Figure 39: Cumulative and Year-on-year Cash Flow of Operations

Key outputs

Description	Value	Unit
Internal Rate of Return - before finance/funding	<0	%
Operating Cost Recovery ratio	0,23	Ratio (revenues / O&M)
Full Cost Recovery ratio	0,17	Ratio (revenues / (O&M + depreciation))
Affordability at project delivery	54,0%	% ((water + sanitation costs) / household incc

8.3 Conclusion

Even with an income of KES 30,000 per month (which is relatively high) and a sponsored tariff, the project is not affordable. Cost recovery of O&M is not possible let alone Full Cost Recovery.

Recommendation: the project needs a step-by-step incremental implementation whereby only households that can afford the system shall participate.

9 Project Risk Analysis

Table 19 presents the risks that have been identified for this HPI and the mitigating measures proposed.

Table 19: Risks and Mitigating Measures

#	Risk Factor	Risk Level	Mitigating measures
1	Landlords increase the rent after improvement of the sanitation and poor people leave the area	High	Implement the ablution[19] blocks and condominium sewers independently of the landlords and have them operated by MOs.
2	MOs are not able to operate and maintain sewers	Very high	○ Capacitating of the MOs; ○ Monitoring of the MO's performance by KIWASCO; ○ Service centres (SMS, Internet, phone) where people can report any wrongdoings.
3	Condominium sewers prohibitively expensive in O&M	High	○ Pilot alternative systems that have lower investment requirements such as a non-sewered sanitation service system.

[19] Applies only in Obunga settlement as Both Manyatta have different approach

10 Environmental and Social Impact Assessment

10.1 Introduction

This section presents the environmental and social impact. It includes recommendations and mitigation and enhancement measures, if and when required. These measures aim to reduce potentially significant adverse impacts to acceptable levels, including traffic, dust, odour, waste, flooding risks, and compensate residual effects. The plan includes prevention or minimization of any potentially adverse environmental and social impacts of the project that have not already been identified, e.g. actions for labour management, contractor management and performance in accordance with good international construction practices. This chapter aims to define certain aspects of the tender documents to be prepared for realization of the KISS Project.

This chapter includes a monitoring programme to provide information on the environmental and socio-economic impacts of the project during implementation and on the effectiveness of mitigation and enhancement measures. The latter intended to allow corrective responses where results are insufficient.

In this chapter we describe the positive and negative environmental and social impact of the proposed HPI, the KISS project. We distinguish between:

- Pre-construction phase;
- Construction phase;
- Post-construction phase;
- O&M phase.

As far as the environmental impact is concerned we describe any positive and negative effects. As far as the negative effects are concerned we describe the mitigating measures that need to bed implemented.

10.2 Pre-construction Mitigation Measures

The following table describes the mitigation measures during the pre-construction phase.

Table 20: Pre construction Mitigation Measures

Impact	Mitigation Measures
Design review	Confirm size and type of main lines and laterals
Sewer connections arranged	Ensure connection of all households in the service areas. Ensure all households have drinking water supply and (pour-) flush toilets to sewer system, as part of the sewerage packages. Provide adequate sanitation services to Project Affected People along trunk main and around WWTP
Routing and design Trunk Main	Ensure that coordination with Kisumu City, KIWASCO, railways and transport authorities is performed.
GHG emissions (design)	Apply reusable building materials where possible
Resettlement Action Plan (RAP) for sewer routes	Implement land acquisition and RAP for sewer routes
Implement Stakeholder Engagement Plan (SEP)	Implement SEP during pre-construction phase

10.3 Construction Mitigation Measures

The mitigation measures during construction are presented in the following table.

Table 21: Construction Mitigation Measures

Impact	Source / Subject	Mitigation Measures
Disturbance to local residents during construction works	Location of construction works close to neighbouring living areas	Contractor shall submit construction yard logistics to Client, including means of separation from living areas
Traffic Management Plan	Construction vehicles and traffic management	The Contractor shall elaborate a Traffic Management Plan, which shall be coordinated with the Kisumu City and the relevant traffic authorities and the police. This plan shall be approved prior to the start of the construction works, and will include: • Traffic routes for construction equipment and building materials, including foreseen timing and frequency of traffic movements; • Identify critical traffic safety and accident risk locations along the route, and propose related mitigation measures, including speed control and road signs; • Timing and access of construction material delivery vehicles to site should be strictly controlled to avoid the disturbances to the local community; • Timing of construction of sewer network and trunk main to limit risks of traffic accidents, traffic jams and nuisance; • Appropriate traffic signage must be erected on site by the Contractor to alert other road users to construction activities; • The Contractor should strategically position the site entry and exit points to ensure that there is minimum impact to the traffic flow on neighbouring areas; • A low speed limit shall be adhered to on site; • Construction vehicles must utilise existing main road and access roads and not create new unauthorised access roads; • The Contractor must ensure that local access roads are not damaged by construction vehicles. If damage does occur, it needs to be attended to immediately to avoid long term problems; • Lighting used to facilitate construction at night should not disturb neighbouring residents. Down lighting should be employed where practicable; • Accessibility of public buildings (among others offices, hospitals, schools, universities, businesses and culturally important sites) needs to be guaranteed during normal working hours. Specific attention shall be given to accessibility for people with disabilities
Storm water discharge to neighbouring residents	Storm water and drainage at construction site	Contractor shall attend storm water drainage on construction site, to prevent soil erosion and flooding
Unauthorized access to site camp	Access points	The site yard must be secure at all times to prevent unauthorised access at the construction site. The Contractor must ensure that construction trenches and material storage areas are sealed off with barrier tape/fences. There must be security at the entrance gate controlling access to the site.
Site contamination	Storage and use of equipment and hazardous substances	Hazardous substances need to be kept in a secured storage area, which is funded and/or has an impermeable floor layer that is able to contain spillages. The hazardous substance storage area needs to be locked at all times. Spill kits must be kept at the hazardous substance storage facility to treat and manage any spills immediately. All contaminated soil/clothing/material must be disposed of at a licensed or

Impact	Source / Subject	Mitigation Measures
		approved hazardous landfill site. The hazardous material storage facility should be sited away from storm water drainage lines. Clear warning signage must be placed at all storage areas containing hazardous substances / materials. Staff dealing with these materials / substances must be aware of their potential hazard and follow the appropriate safety measures.
Site contamination	Solid waste handling	Sufficient waste bins shall be provided on site to encourage waste separation and for recycling purposes, if such systems are available. Refuse bins shall be placed at strategic positions to ensure that litter does not accumulate on site. Construction workers need to be encouraged to use the waste bins provided at all times, and littering should be prohibited. The Contractor must engage with the local authorities or a private waste service provider regarding to the provision of waste containers. Waste containers should be kept on site to dispose of construction rubble. Containers must be removed when they fill up to maintain a clean site. Waste must be disposed of at the official landfill, approved by the authorities. If the waste disposal facility does not issue a record of the waste disposed, it is recommended that the Contractor keep a record at the construction site of the volumes of waste taken to the facility. Burning of waste on site or in waste containers is prohibited. Hazardous waste may not be stored on site in excess of a 90 calendar day period.
Site contamination	Sanitation	The Contractor shall install toilets on the site and place them in a designated area. The Contractor needs to establish hand washing facilities and soap to maintain good hygiene on site. Staff shall be sensitised to use these facilities at all times. Ablution facilities shall be within 100m from workplaces. The Contractor should arrange that the service provider services the toilets regularly.
Air and soil pollution	Handling of cement, asphalt, fuel, paints and other chemicals	Cement or asphalt mixing must take place on impermeable/-protected surfaces. Use of ready mixed cement/asphalt will require the establishment by the Contractor of proper truck and equipment wash bays with an impermeable floor layer. Used paint tins/brushes must be disposed of as hazardous waste and paint washings collected in receptacles for later safe disposal. Paint must not be washed into storm water drains on site.
GHG Emissions	Air emissions	Purchase reusable building materials where possible; minimize construction transport distances and related transport air pollution
Noise	Construction noise	Construction works related noise levels must be kept within acceptable limits. The noise and sound generated shall adhere to the Tanzanian noise standard specifications and take account of nearby residents when work is performed at night. No sirens and hooters may be utilized except where required or in emergencies. The playing of loud music at the construction yard is prohibited. The Contractor should keep the local community informed of unavoidable noisy activities and their duration.
Dust generation	Dust from excavations, cement and construction materials	Excavations and other site clearing activities shall only be undertaken during agreed working times to avoid the spreading of sand and dust into neighbouring areas. The Contractor shall be responsible for dust control (water spraying) on site to ensure no nuisance is caused to the

Impact	Source / Subject	Mitigation Measures
		neighbouring landowners and the local community. A speed of 20 km/h shall not be exceeded on site. The Contractor must attend to complaints resulting from dust generation immediately. The Contractor should commence with rehabilitation of exposed soil surfaces as soon as practically possible after completion of earthworks. All material resulting from excavation must be put in a location protected from wind and regularly sprinkled with water until reused for fill Dust suppression measures must be implemented where required.
Fire risks	Potential fires	The Contractor shall have operational fire-fighting equipment available on site at all times. The level and capacities shall be sufficient to address any major fire outbreak. Open fires shall be prohibited on the site
Surface Water pollution	Chemical and hazardous materials	All hazardous materials shall be placed in containment areas on sealed floor surfaces and 100m away from any water bodies. The Contractor must remove contaminated wastewater resulting from construction activities and dispose of it at a licensed commercial wastewater treatment facility. Temporary cut-off drains and berms must be erected in order to capture surplus storm water and promote infiltration. Used oil on site must either be collected by a registered waste oil collector or disposed of to a registered processing or disposal facility. Manual cement/asphalt mixing activities must take place in a lined are a to prevent runoff from the area entering the storm water drainage system. It is recommended that ready mixed cement/asphalt be utilised to prevent onsite water pollution and impacts on surrounding areas, where possible. A designated, properly designed impermeable washing area for vehicle and the Contractor must establish construction equipment if this cannot be undertaken off-site. Any accidental spillages that occur on site must be contained and remediated as soon as possible. On site ablution facilities need to be serviced regularly and placed in a special area. Storm water needs to be managed especially during the wet season. It should not be allowed to drain into trenches nor should it be allowed to flood areas where construction materials or equipment are stored. A storm water management plan must be prepared by the Contractor and approved by the ESO, ECO and /or the Independent Engineer. Water pumped from any excavations/trenches must be safely disposed of and be free from silt and sediments.
Safe water use	Leakage and wasting	The contractor needs to provide safe drinking water to its employees, meanwhile avoiding wastage and timely repair of leakages
Disturbance of wetland ecology	During construction maturation ponds	Construction work site shall be physically separated from surrounding wetlands/ paddy fields. Nuisance and pollution of the surrounding wetlands shall be fully prevented, including dust, noise, wastewater emissions, and particularly waste generation and disposal. The contractor shall prevent that animals, fishes and other fauna will be disturbed, trapped, hunted or killed by the workers and staff involved in the construction works. In case of emergencies accidents with impacts on the wetland ecology beyond the boundaries of the construction site, the relevant authorities shall be informed immediately, and related mitigation measures shall be prepared and implemented as soon as possible
Occupational	Workers and	A health and safety plan shall be drawn up by the Contractor

Impact	Source / Subject	Mitigation Measures
Health and Safety Impacts	community safety	to ensure the safety of workers. Contractors shall ensure that all equipment is maintained in a safe operating condition. A record of health and safety incidents shall be kept on site. Any health and safety incidents shall be reported to the Employer immediately. First aid facilities shall be available on site at all times. Workers have the right to refuse work in unsafe conditions. Material stockpiles or stacks shall be stable and well secured to avoid collapse and possible injury to site workers.
Occupational Health and Safety Impacts	Use of Protective gear	Personal Protective Equipment (PPE) shall be made available to all workers and use of PPE shall be made compulsory. The minimum PPE includes: • Hard hat; • Safety shoes • Overalls; • Gloves; • Reflector vests; Certain operations may require additional PPE such as: • Ear plugs; • Eye protection glasses; • Face masks; No person is to enter the construction site without the necessary PPE.
Occupational Health and Safety Impacts	Site safety issues	The construction yard shall remain fenced at all times. Potentially hazardous areas such as trenches are to be demarcated and clearly marked. Adequate warning signs of hazardous working areas shall be erected in suitable locations. Emergency numbers for the local police, clinic/hospital and fire department shall be placed in a prominent area. Firefighting equipment shall be placed in prominent positions across the site where it is easily accessible. This includes fire extinguishers, a fire blanket as well as a water tank. Workers need to be trained on how to operate the firefighting equipment. All flammable substances shall be stored in safe areas which do not pose an ignition risk. Smoking may only be conducted in demarcated areas as agreed upon by the SHE officer and the Contractor. A speed limit of 20km/h shall be adhered to by all construction vehicles and machinery. The works that take place in the public space, especially the construction of the sewer network and the trunk main, need specific health & safety planning, traffic safety planning, and training of the construction workers to limit public the safety risks, such as falling into holes, pools or ditches or collisions with construction equipment.
Stakeholder Engagement Planning	Stakeholders	Stakeholder engagement should continue into the construction phase. Specific attention should be given to communication about public health & safety risks and measures to mitigate these. The project council with representatives of the local residents should be in regular contact with the Kisumu City and KIWASCO. A grievance mechanism should be established and managed.
Neighbouring Community	Community relations	The Contractor must be courteous at all times when dealing with the neighbouring community and their rights need to be respected at all times. A complaints register should be kept on site and the Contractor must attend to any public complaints as soon as possible.

Impact	Source / Subject	Mitigation Measures
		No interruptions other than those negotiated shall be allowed to any essential services, including access to water sources and local infrastructure. Damage to local infrastructure shall not be tolerated and any damage shall be rectified immediately by the Contractor. A record of all damages and remedial actions shall be kept on site. Where possible, unskilled job opportunities should be afforded to local community members in order to transfer employment skills. The Contractor will need to engage with the municipal local Councillors or other community leaders to assist with the recruitment of the local unskilled labour when required.
Neighbouring Community Impacts	Infection risks from HIV / AIDS. Ebola and other diseases	The Contractor must coordinate and implement an awareness campaign on HIV/Aids, Malaria and other potential sicknesses within Kisumu. The campaign must aim at sensitizing the employees and neighbouring communities to potential health risks and regulating behaviour.
Neighbouring Community Impacts	Alcohol and drug abuse	The consumption of alcohol and drugs by employees must be prohibited on and surrounding the construction area
Employment opportunities	Labour recruitment	Where possible local residents, including women, shall be given the opportunity to apply for construction jobs and to supply materials, food and beverage.

10.4 Post-construction Mitigation Measures

Following the completion of the construction works, the following post-construction actions need to be implemented by the Contractor:

- The construction yard is to be checked for spills of substances such as oil, paint, chemicals, other types of waste, and these shall be cleaned up;
- The Contractor must arrange for the cancellation of all temporary services, e.g. toilets;
- All areas where temporary services were installed are to be rehabilitated to the satisfaction of the local authorities and the Independent Engineer, if assigned;
- Surfaces are to be checked for waste products from activities such as concreting/asphalting and cleared accordingly;
- All surfaces hardened due to construction activities are to be ripped and concrete/asphalt material removed;
- Topsoil must be replaced back to disturbed surfaces and used to re- vegetate disturbed areas;
- All construction waste and rubble is to be removed from the site and disposed of to the municipal or recognized/approved landfill site;
- The site is to be cleared of all litter and temporary cabins and structures should be dismantled;
- All residual stockpiles must be removed from the site;
- The Contractor must repair any damage that the construction works has caused to neighbouring properties;
- Quarries used for sourcing construction material must be rehabilitated accordingly.

Public Information to Prepare for Construction Works

The Project Affected People and general public shall be informed through the Kisumu City about the type and duration of the upcoming construction works, as well as during these works. This shall include information on the timing and planning of the construction works, the impacts on roads and traffic such as road closures and rerouting of vehicle and pedestrian traffic, potential temporary environmental nuisance and temporary traffic signs and warnings.

10.5 Mitigation Measures during Operation and Maintenance

The mitigation measures during operation and maintenance are presented in the following table.

Table 22: Post Construction mitigation Measures

Impact	Mitigation Measures
Monitoring and reporting	The operator should maintain records of leakages and breakages of the sewer line that may lead lo spillage and/or other hazards that that may have an impact on the environment. The information should be reviewed and evaluated to improve the effectiveness of the monitoring. It should further include procedures for handling of accidents and disaster preparedness.
Occupational Health and Safety during operations (management system)	Establish an OH&S management system. Supervisors must first have the proper attitude and interest in OH&S, and shall gain a full working knowledge and understanding of the many ways in which they can prevent accidents and occupational illness.
Occupational Health and Safety during operations (fire prevention)	All equipment, buildings and fire alarm systems should comply with local, state, and national fire codes and standards
Influent Water Quality	Establish influent monitoring to confirm that the influent is not mixed with industrial produced wastewater
Wastewater Treatment Fees	Ensure financial sustainable operations, including effective and adequate fee collection system and adequate pro-poor provisions
Implement Stakeholder Engagement Plan	Implement SEP during operational phase
Inequality Compensation	Provide piped water supply and sanitation services for project affected people
Labour Opportunities	Assess operational job opportunities for local residents

11 Conclusions and Recommendations

Table 23 presents the conclusions and recommendations of the Feasibility Study on Kisumu informal Settlement Sanitation.

Table 23 Conclusions and Recommendations

Conclusions	Recommendations
The sanitary conditions in the informal settlements in Kisumu are very poor: there are insufficient facilities and the existing facilities are inadequate.	Immediate action to improve the sanitary conditions.
Kisumu does not have a clear idea on the existing sewerage system, existing sewage flows and future needs. The success of condominium sewers depends on the overall system.	The preparation of a wastewater and sanitation master plan needs to be a pre-requisite for any condominium sewerage project.
KIWASCO has many challenges in operating and maintaining sewerage and wastewater treatment. The success of condominium sewers depends on proper O&M of the general system.	Improved O&M by KIWASCO of the overall sewerage need to be a pre-requisite for any condominium sewerage project. MOs need to be trained and equipped adequately.
The condominium sewerage as proposed by LVSWSB based on the DMM is both expensive and risky.	Implement the condominium sewerage in a phased manner and pilot non-sewered sanitation service models. This is based on the fact that operation of the pilot of the Pamoja Trust is yet to give sufficient data and insight.
The condominium sewerage as proposed by LVSWSB was to be connected to a decentralized WWTP. Existing WWTPs are underutilized and can be fed under gravity.	Use existing WWTPs to treat the sewage.

Appendix 1: Proposal LVSWSB

The following proposal was received on 13 April 2016.

PROPOSED DEVELOPMENT OF CONDOMINIUM SEWERS AND DECENTRALISED SEPTIC SLUDGE SYSTEM IN INFORMAL SETTLEMENTS OF MANYATTA AND OBUNGA

<table>
<tr><td>Town</td><td colspan="6">Kisumu City, Population – 482,588 (2015)</td></tr>
<tr><td>Target Location</td><td colspan="6">Manyatta and Obunga Informal settlements</td></tr>
<tr><td>Unique Characteristics</td><td colspan="6">Informal settlements, dense population, high prevalence of poverty, with adequate access to water services but low sanitation coverage</td></tr>
<tr><td>Target Population</td><td colspan="6"><table>
<tr><td></td><td colspan="2">Total (2015)</td><td colspan="2">Target (90%)-(2015)</td><td rowspan="2">Area (Ha)</td></tr>
<tr><td></td><td>Population</td><td>Household</td><td>Population</td><td>Household</td></tr>
<tr><td>Manyatta A</td><td>57,319</td><td>14,956</td><td>51,587</td><td>13,460</td><td>2.4</td></tr>
<tr><td>Manyatta B</td><td>33,376</td><td>9,323</td><td>30,039</td><td>8,391</td><td>1.3</td></tr>
<tr><td>Obunga (Nyawita)</td><td>17,609</td><td>4,894</td><td>15,848</td><td>4,405</td><td>2.5</td></tr>
<tr><td>Obunga (Kanyakwar)</td><td>14,990</td><td>4,242</td><td>13,491</td><td>3,818</td><td>6.6</td></tr>
<tr><td>Total</td><td>123,294</td><td>33,416</td><td>110,965</td><td>30,074</td><td>13</td></tr>
<tr><td>Investment (Euros)</td><td></td><td></td><td>4,000,000</td><td>4,000,000</td><td></td></tr>
<tr><td>Per Capita Invest</td><td></td><td></td><td>36</td><td>133</td><td></td></tr>
</table></td></tr>
<tr><td></td><td colspan="6"></td></tr>
<tr><td>Proposed Activities</td><td colspan="6">1. Detailed Feasibility Study and Design of Condominium sewer system and decentralized septic sludge management including development of Biogas generation system
2. Construction of Condominium Sewers system- approximately – 24Km: DN 110- DN 300;(6km in Manyatta A, 8km in Manyatta B, 6km in Obunga (Kanyakwar) and 4km in Obunga (Nyawita)
3. Construction of decentralized septic sludge; tanks sizes- 50m3-1000m3;
4. Procurement of 2No Vacuum Tankers
5. Construction, test-operation of 2No.BIOGAS Generation units; 1No in Obunga and 1No in Manyatta.
6. Accompanying Measures support – training of KIWASCO, training of Community group (Delegated Management Model), social and environmental safety marketing and maintenance equipment.</td></tr>
<tr><td>Estimated Cost</td><td colspan="6">Euros 4Million</td></tr>
<tr><td>Next steps</td><td colspan="6">Detailed Feasibility Study
Environmental Impact Assessment :
Social and Engineering Design
Construction of Condominium sewers,
Accompanying Measures Support
Commissioning and Handing Over</td></tr>
<tr><td>Implementation Plan</td><td colspan="6">Studies : May 2016 – December 2016
Tendering; January 2017- June 2017
Implementation: August 2017 – December 2018
Commissioning: February 2019</td></tr>
</table>

Source: Project Formulation Report – Kisumu; Atkins; Section 2.7

Appendix 2: References

- Sewerage Treatment in Hot Climates, D. Mara
- Waste Stabilization Ponds- A design Manual for East Africa, D. Mara et all
- MOPW&H Manual for Civil Works detail
- Design calculation in wastewater treatment, F. Wilson
- Design manual for waste stabilization ponds in India
- Design manual for simplified sewerage system: Dr D Mara and Dr Gehan S. of Leeds University

Appendix 3: Design Criteria

Design criteria Sewerage network
A water-borne sewage disposal system is justified from technical and economic point of view when the population density of the place is above 150 persons per ha.

The design criteria adopted for this preliminary design conforms to the following:

- Report No. 9 – Selection and design criteria for Sewerage Projects: WHO 1973;
- Wastewater Engineering, Treatment Works, Disposal and Reuse; Metcalf and Eddy Inc. 3rd 1992;
- Sewerage Treatment in Hot Climates, D. Mara;
- Waste Stabilization Ponds- A design Manual for East Africa, D. Mara et all;
- MOPW&H Manual for Civil Works detail;
- Design calculation in wastewater treatment, F. Wilson;
- Design manual for waste stabilization ponds in India.

Type of sewerage systems
In sewerage, three types of systems are normally recognized:

- Separate system - which takes no storm water;
- Combined – which disposes of all the storm water drained from the sewered area;
- Partially separate system – which takes a predetermined quantity of storm water.

A separate sewerage system has been proposed for the project area. This is inevitable given the existing legal framework for the water sector where the Ministry of Water and Irrigation is in charge of water and sewerage services whereas the Local Authorities are in charge of road drainage and maintenance. It is also obvious that separate sanitary sewers are less costly to construct and operate.

Prediction of foul sewage flows for the project:
The estimation of the sewer flows has been done according to the KIWASCO and the World Bank guidelines on the wastewater flows. The formula adopted for calculation of total sewerage flows is therefore:

$$DWF = \frac{P*G}{86400} * \left(1 + \frac{S_A}{100}\right) + \frac{E*A_E}{86.4} + I\left(A_E + A_P\right)$$

and

$$QR = FR(DWF - 1) + 1 \text{ in litres/sec}$$

Where QR = Peak flow rate litres/sec
FR = Peak flow factor litres/sec
DWF = Dry weather flow litres/sec
P = Population No. of persons
G = Water consumption litres/person/day
SA = Splash area as
= Percentage of P x G (normally taken as 15%)
E = Commercial and Institutional Waste water flow (m^3/ha/day)
AE = Commercial & Institutional Area (Hectares)
I = Infiltration water flow rate (litres/sec)

Peak flows have been taken as follows:-

DWF (litres/second)		Peak factor (FR)
Less than	6.0	7.5
	12	6.6
	60	5.5
	5.0	

Infiltration

The amounts of groundwater that can be expected to infiltrate into the sewers depends on the following factors:

- Number of joints
- Type of pipe
- Type of joints
- Ground water conditions
- Workmanship

Ground water infiltration rate of 0.025 litres/sec/ha has been adopted for the sewer designs. The infiltration rate is taken as constant for the whole of drainage area and throughout the design life of the project.

Rising mains:

For calculations for rising mains, the Hazen-Williams equation is utilized with a C-value of 110.

Eqn. 2 $v = k\, C\, R^{0.63}\, S^{0.54}$

Where v = velocity (m/s)

K = unit conversion factor = 0.85

C = Friction loss coefficient

R = Hydraulic Radius (m)

S = slope (m/m)

To ensure that self-cleansing is achieved, the sewers will be designed to have a gradient that attains self-cleansing velocity at least once a day. A minimum velocity of 0.75 m/s has been used in design, in order to reduce the build-up of hydrogen sulphide in the sewers and to attain the higher velocities required for self-cleansing during the minimum night flows.

To avoid abrasion caused by grit in the sewage, maximum design velocities in the sewers have been kept to <3.0 m/s. Where the gradient is steep and the flow velocity is expected to exceed 3.0 m/s, drop manholes will be introduced to decrease the velocity.

The minimum and maximum gradients for sewers resulting from the above considerations have been kept within the limits given in Table 24 below. Where self-cleansing velocity may not be attained due to the flat gradients, flushing tanks will be designed along the mains at the affected sections.

Table 24: Sewer Pipe Gradients

	Pipe Gradients (%)		
Diameter of Pipe, mm	**Min.**	**Max.**	**Average**
House Connections	10	100	20
200 – 300	5	66	10
300 – 600	3.5	50	5.0
600 – 1000	1.5	33	3.5
1000 – 2000	0.3	20	1.5

Calculation of sewer sizes:

Colebrook-White Equation for Transitional Flow has been adopted for use in the sizing of the sewers. The equation is as follows:

$$\frac{1}{\sqrt{\lambda}} = -2log\left[\frac{k}{3.7D} + \frac{2.51}{Re\sqrt{\lambda}}\right]$$

Where: λ = The Darcy-Weisback friction factor= $\frac{2gDI}{v^2}$
Re= Reynold's number
D= Diameter of pipe
k= Absolute roughness of the pipe wall
I= Hydraulic gradient

Charts prepared from Colebrook-White equation are available for use in sizing the sewer reticulation.

Based on the derived wastewater peak flow rates, the sewer sizes have been calculated on the basis of Colebrook-White equation with k value for concrete pipe being taken as 1.5mm.

The minimum size of main sewers to be adopted is 225mm diameter. Property/house connections will be designed with a minimum diameter of 100 mm. The sewers are assumed full when flowing half full.

Location of foul sewer lines:

In order to avoid inaccessibility of sewers during maintenance, sewers have been proposed along road reserves and drainage river valleys. Sewers will also be laid outside the road pavements to avoid expensive concrete protection of sewers and also to avoid interruption in traffic during maintenance.

Gradient of foul sewer lines:

Minimum gradients in sewers adopted are to ensure that velocity of flow is not less than 0.6m/sec at least once a day. Preferably the sewer slopes are to be such that that self-cleaning velocity of 0.75m/sec will be ensured.

In the preliminary design, a minimum slope of 0.5% has been adopted. At the detailed design stage, it is expected that a proper analysis will be undertaken to base the design on tractive force required to ensure self-cleansing rather on minimum velocities.

Spacing of manholes:
Manholes permit the inspection, cleaning and maintenance of sewers for the removal of blockages. As such manholes would be provided at changes in horizontal alignment, vertical grade and at spacing not exceeding 60 metre centres for the branch main. The Trunk Sewer lines along the river will to be spaced at 90m interval.

Precast manhole rings are recommended for use in the construction of manholes in this project.

In public roads, the manhole covers are recommended to be made of heavy cast iron frame and cover with holes for ventilation.

Manholes would be sited in areas so as to ensure that flood waters do not drain into the sanitary sewers.

Material for foul sewer pipes:

Three types of pipes are generally used in Tanzania namely uPVC flexible (i.e. with rubber rings) sewer pipes, rigid jointed concrete pipes and flexible jointed (i.e. with rubber ring) concrete pipes.

Concrete pipes are structurally more stable and durable and would require lower protection backfill covers. However, there is risk of chemical attacks on concrete, which is likely to reduce the life span of concrete in situations where harsh industrial wastes are released. The pipes have higher frictional resistance values and therefore in flat areas where the ground gradients

are a limiting factor, they would cause deeper excavations and therefore higher construction costs. Due to their higher porosity they are bound to allow higher ingress of groundwater. They are generally heavy to transport over long distances with the resultant higher costs and number of breakages.

The uPVC pipes on the other hand have smaller frictional resistance and allow little ingress of groundwater. The pipes are light to transport and therefore would incur less costs in transportation over longer distances. The pipes are flexible and the incidences of breakages during transportation are minimal. The pipes can easily be sourced from within the country. Due to their resistance to chemical attacks, they can be used in special circumstances such as in marshy areas or where the pH of the soils is likely to be high.

Of the three types of pipes described above the most commonly used pipes are rigid jointed concrete pipes. These have the disadvantage of requiring expensive concrete bed and haunches.

On the other hand, flexible jointed concrete pipes require a granular bedding only but incorporate an expensive socket and spigot joint with a rubber ring.

In view of the above arguments, and mainly due to the expected costs, uPVC pipes were chosen for this project.

Standard, workmanship and testing:

Sewers will be constructed to connect such that their soffits are at level and their depths to be sufficient to take the gravity flows of sewage from the adjacent developments being served. The sewer depths deeper than 6.0m will be avoided and a minimum depth should be 0.6m deep.
All pipes with a cover less than 1.25m and are in areas prone to vehicular traffic are to have Reinforced Concrete surround protection.
On completion of construction, all sewers would be tested for water tightness and infiltration. Concrete works to be closely supervised. Water tests shall be taken by applying minimum head of 1.0 metre to every section of sewer length.

Design criteria for sewage pumping stations:

The use of pumping stations will be avoided as much as possible due to operational and maintenance problems associated with their operations. However, where their installation cannot be avoided, the following design criteria will be applied.

Pump sump (wet wells):
In the design of the wet wells, the maximum number of starts per hour has been limited in accordance with the following values;

i. Motor capacity < 10kW - 10/hr
ii. Motor capacity >10 kW - 8/hr

The volume between START and STOP levels will be calculated according to the following equation:

$V_{min.} = 0.9*Q /z$

Where V_{min} = Minimum permissible volume between START and STOP levels in m3
Q = Pump capacity in l/s
z = Permissible number of starts per hour

Pumping head:

Static head
The static head has been calculated as the difference between the minimum level at suction point (entry into the pump suction side) and the delivery level.

Friction head

Friction head has been calculated as the sum of the continuous losses in the pressure main and the fittings losses (using the D'arcy –Weisbach equation) and the fittings losses.

Eqn.4 $h_f = f \cdot L/D \cdot v^2/2g$

Where: h_f = head losses due to friction (m)
f = friction factor (unit less)
L/D= ration of length (m/m)
v = flow velocity (m/s)
g = 9.81 (m/s^2)

Pump room (dry well):

This is placed in a convenient place and pumps are installed inside it. Its location should be such that the pumping sets function easily. It is a RC and masonry room rectangular shape in plan. The sewerage pumping set, it's driving units, control valves and necessary pipes with the fittings are installed in it. Its sizing depends only on the required space for the operator to move during installation, operation, maintenance and repairs. It is proposed that the pumping set be installed on the dry well as opposed to the submerged position, because of maintenance problems associated with the submerged option.

Pipes, valves fittings etc. in the pumping station:

The cast iron pipes with flanged joints should be provided in all the installation works at the pumping station. The flanged joints provide easiness in dismantling and repair of the pumping station equipment. To reduce the loss in head, the number of valves, bends, junctions etc., should be kept at a minimum.

A gate valve should be provided on the sewer line just before the wet well and on the suction and discharge pipes to close the flow of the sewage during maintenance, inspection and repair of the pumps.

Control devices and their location:
Since it is common practice to install pumps of a higher capacity, automatic control devices need to be provided to cope with the continuously varying sewage flow rates. The operator should ensure that the time between switching off a pump and switching on another should not be more than 5 minutes.

The location of the driving units should:

- Be as close as possible to the pumps they have to drive;
- The moving motor should be away from the damp or hot surroundings.

Appendix 4: Population Tables

Table 25: Population Distribution by Sex of the Top Five Populous Urban Centres of Kenya, 2009 Census

Status	Urban Centre		Core Urban Population			Peri-Urban Population			Rural Population			Total Population		
			Male	Female	Total	Male	Female	Total	Male	Female	Total	Male	Female	Total
City	Nairobi	Count	1,602,104	1,531,414	3,133,518							1,602,104	1,531,414	3,133,518
		%	51.13	48.87	100.00	0.00	0.00	0.00	0.00	0.00	0.00	51.13	48.87	100.00
	Mombasa	Count	473,433	441,668	915,101	12,775	10,255	23,030				486,208	451,923	938,131
		%	50.47	47.08	97.55	1.36	1.09	2.45	0.00	0.00	0.00	51.83	48.17	100.00
	Kisumu	Count	131,062	128,196	259,258	62,816	66,237	129,053	10,356	11,261	21,617	204,234	205,694	409,928
		%	31.97	31.27	63.24	15.32	16.16	31.48	2.53	2.75	5.27	49.82	50.18	100.00
Municipality	Nakuru	Count	145,038	141,373	286,411	10,843	10,736	21,579				155,881	152,109	307,990
		%	47.09	45.90	92.99	3.52	3.49	7.01	0.00	0.00	0.00	50.61	49.39	100.00
	Eldoret	Count	127,808	124,253	252,061	18,788	18,531	37,319				146,596	142,784	289,380
		%	44.17	42.94	87.10	6.49	6.40	12.90	0.00	0.00	0.00	50.66	49.34	100.00
Total		Count	**2,479,445**	**2,366,904**	**4,846,349**	**105,222**	**105,759**	**210,981**	**10,356**	**11,261**	**21,617**	**2,595,023**	**2,483,924**	**5,078,947**
Total: Kenya		Count	**4,519,578**	**4,414,586**	**8,934,164**	**1,293,269**	**1,318,138**	**2,611,407**	**1,069,773**	**1,106,725**	**2,176,498**	**6,882,620**	**6,839,449**	**13,722,069**
(Total/Total Kenya)		%	**32.94**	**32.17**	**65.11**	**9.42**	**9.61**	**19.03**	**7.80**	**8.07**	**15.86**	**50.16**	**49.84**	**100.00**

Source: https://opendata.go.ke/Population/Population-Distribution-by-Sex-in-Urban-Centres-an/yc6j-ekrh

Table 26: Population, Households and Density by the 2009 Census Results

Constituency	Ward	Sub-Location	Male	Female	Total	Households	Area in Sq. Km.	Population Density
Kisumu Central	Kondele	Manyatta A	23,503	24,501	48,004	12,525	2.36	20,333.79
	Railways	Nyawita	7,526	7,221	14,747	4,099	1.31	11,281.36
Kisumu East	Manyatta B	Manyatta B	14,219	13,733	27,952	7,808	2.54	10,998.23
Total (Manyatta A, Nyawita, and Manyatta B)			45,248	45,455	90,703	24,432	6.21	14,605.96

Source: https://opendata.go.ke/Population/Census-Volume-1-Question-1-Population-Households-a/wd27-eki2

Table 27: Households Main Mode of Human Waste Disposal, 2009 Census Results

Constituency	Ward	Sub-Location		Main Sewer	Septic Tank	Cess Pool	VIP Pit Latrine	Pit Latrine (Covered/ Uncovered)	Bucket	Bush	Other	Total
Kisumu Central	Kondele	Manyatta A	Count	597	445	8	771	10,616	23	43	22	12,525
			% with	4.77	3.55	0.06	6.16	84.76	0.18	0.34	0.18	100.00
	Railways	Nyawita	Count	366	473	7	213	3,017	19	1	3	4,099
			% with	8.93	11.54	0.17	5.20	73.60	0.46	0.02	0.07	100.00
Kisumu East	Manyatta B	Manyatta B	Count	249	142	17	465	6,818	12	101	4	7,808
			% with	3.19	1.82	0.22	5.96	87.32	0.15	1.29	0.05	100.00
Total (Manyatta A, Manyatta B, and Nyawita Sub-Locations			Count	1,212	1,060	32	1,449	20,451	54	145	29	24,432
			% with	4.96	4.34	0.13	5.93	83.71	0.22	0.59	0.12	100.00

Source: https://opendata.go.ke/-Environment-And-Natural-Resources/2009-Census-Volume-II-Question-9-Households-Main-M/nv98-ph2f

Table 28: Households Access to Water, 2009 Census Results

Constituency	Ward	Sub-Location		Pond/ Dam	Lake	Stream	Spring / Well / Borehole	Piped into dwelling	Piped	Jabia / Rain/ Harvested	Water Vendor	Other	Total
Kisumu Central	Kondele	Manyatta A	Count	15	2	11	4,865	288	3,643	22	3,678	1	12,525
			% with	0.12	0.02	0.09	38.84	2.30	29.09	0.18	29.37	0.01	100.00
	Railways	Nyawita	Count	17	0	4	1,175	212	1,418	6	1,266	1	4,099
			% with	0.41	0.00	0.10	28.67	5.17	34.59	0.15	30.89	0.02	100.00
Kisumu East	Manyatta B	Manyatta B	Count	95	0	14	1,584	252	3,388	26	2,443	6	7,808
			% with	1.22	0.00	0.18	20.29	3.23	43.39	0.33	31.29	0.08	100.00
Total (Manyatta A, Manyatta B, and Nyawita Sub-Locations)			Count	127	2	29	7,624	752	8,449	54	7,387	8	24,432
			% with	0.52	0.01	0.12	31.20	3.08	34.58	0.22	30.23	0.03	100.00

Source: https://www.opendata.go.ke/Water-and-Sanitation/Housheold-Access-To-Water-By-Sublocation-2009/g3dc-dk7w

Appendix 5: MEMO Questions raised by KfW

Background. In the final workshop on the Feasibility Studies for the "LVB IWRM Programme with High Priority Investments (HPI)" on 3 November 2016, a ranking of the 4 HPIs will be presented on the basis of the results of the Draft Final Feasibility Studies which were submitted for final review in August 2016, taking into account final feedback and questions received from KfW. On 24 October 2016, KfW requested clarification on some aspects of the FS of the selected HPIs.

Aim of this memo. To clarify the pending issues that were raised by KfW so that an unambiguous decision can be made.

HPI Kisumu. Question on relatively low ranking of the HPI. HPI Kisumu is a typical pro-poor project and fulfils KfW's ambition to improve the lives of the urban poor. Why does this project rank relatively low compared to the others?

HPI Kisumu. Question on relatively low ranking of the HPI. Kisumu scored relatively low on the aspects 'Financial sustainability & affordability' and 'Capacity of the implementing institutions'.

As far as 'Financial sustainability & affordability' is concerned, we remarked that '*This project is improving the lives of the poorest of the poor an can only sustain and be affordable if O&M charges are being subsidized'*. According to us, the fact that Kiwasco is supposed to be subsidizing the poor is a major risk: as long as the socio-economical conditions are favourable, this might work well. However, what will be the situation if utilities would be come more autonomous operating entities? In those cases utilities will turn to the central or local governments for financial support as their first priority will be to survive financially.

As far as 'Capacity of the implementing institutions' is concerned, we remarked: *"The proponent has the organizational and financial capability to deliver the project and its outputs. Willingness to do so needs to be seen".* In our Final Draft report we observed "*Formal operators are not keen on servicing the poor and KIWASCO follows a DMM approach for servicing the poor (section 2.6)".* Hence, the Delegated Management Model, used for drinking water will also be used for wastewater. This is new for both parties and a careful implementation is needed. Therefore it is suggested to develop this in a first / pilot phase and evaluate if the Financial, Institutional, Environmental, Technological and Socio-Economical-Cultural set-up favours the poor.