SFD Promotion Initiative

Nakuru
Kenya

Final Report

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On behalf of Federal Ministry for Economic Cooperation and Development

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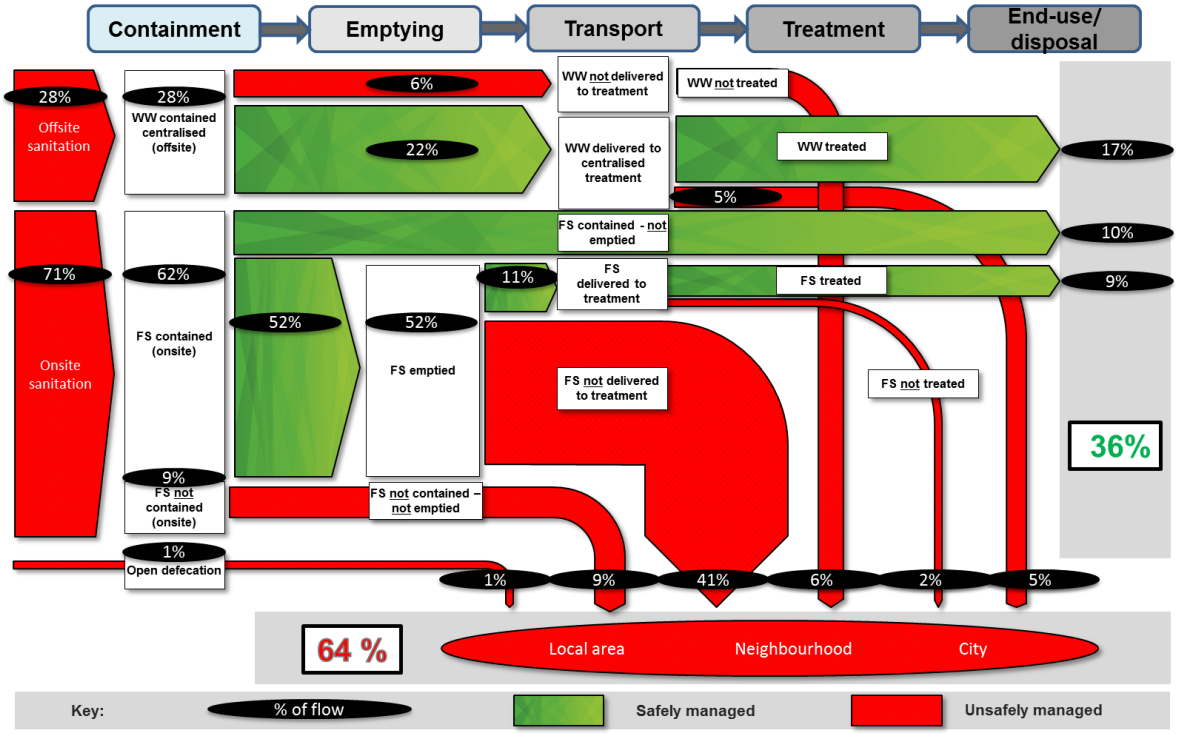
1. The Diagram

Nakuru 17/11/2015
Desk based



2. Diagram information

The excreta flow diagram (SFD) was created through desk based research by WEDC (Water, Engineering and Development Centre), Loughborough University.

Collaborating partners:
Water Sanitation for the Urban Poor (WSUP) Kenya and Nakuru County Government.

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3. General city information

Nakuru is the fourth largest town in Kenya and lies in the Rift valley (Ojwando & Muta, 2009). The town covers approximately 290km^2. The town is sandwiched between the National Park and the Megengai crater, so only occupies 102km^2 (Mwangi, 2003; Raude eat al, 2009). Its economy is driven by commerce, industry, agriculture and services (Mwangi, 2003).

Nakuru has two rainy seasons; the main one from March to May and a shorter one from November to December (Sarfaribookings, 2015). It slopes steeply from north to south (Umande & Practical Action, 2012). Soils are predominately volcanic and porous, and there is a major geological fault zone running across the town (Mwangi, 2003; Umande & Practical Action, 2012). There is little run-off, but localised flooding occasionally occurs in low lying areas during the longer rainy season (Mwangi, 2003).

The boundary used for the SFD was the administrative municipal boundary, as this predominately encompasses the urban population. The current estimated population is 369,839 (Nakuru County, 2013). It is estimated that over half of the population live in Low Income Areas (LIAs) (Mwanzia & Misati, 2013; NAWASSCO, 2013).

4. Service delivery context

The right to sanitation is entrenched in the Constitution of Kenya (WASREB, 2014). **Policy, legislation, and institutions** in Kenya are currently going through a transition period, as the Water Act (2002) is superseded by the pending National Water Bill (2014).

National policies for sanitation in Kenya are formed in the Ministry of Water and Irrigation (MoWI) which focuses on offsite urban sanitation. In 2008 the Ministry of Public Health and Sanitation was formed, and was given the remit for onsite sanitation in rural areas. This means there is a policy gap, as onsite urban sanitation is not covered by either ministry. This sector is regulated through polices from the National Environmental Management Authority (NEMA).

The Water Act (2002) emerged from constitutional reform in Kenya. Under this Act the current regulatory framework for water and sanitation (offsite urban only) was established. It also initiated the devolution of these services from central government.

The National Environmental Sanitation and Hygiene Policy (NESHP) focuses on the coordination of stakeholders in the sanitation and hygiene sector to meet the MDG target for sanitation (Umande & Practical Action, 2012). NESHP's aim has been adopted locally in the Nakuru County Sanitation Program 2012-2016 (NAWASSCO, 2013). This program includes the development of large scale transport, emptying and treatment services, which include processing of faecal sludge (NAWASSCO, 2013).

Nakuru Municipal Council (NMC) is responsible for the development and provision of services, which includes sanitation services (Umande & Practical Action, 2012). This covers emptying services for onsite sanitation systems, and public sanitation service provision (Umande & Practical Action, 2012). Nakuru Water and Sanitation Services Company (NAWASSCO) are tasked with delivering these services in the draft Nakuru County Water Bill.

The current institutions were formed under the Water Act 2002. The Water Services Regulatory Board (WASREB) is the independent regulator for the sector. Under this Act, the ownership of assets were devolved to a regional level through the Water Service Boards (WSBs) who then contracted them to Water Service Providers (WSPs). WSPs are able to access funds for improving water and sanitation in LIAs through the Water Services Trust Fund (WSTF) (WSP, 2011).

Under this system WASREB does not have total authority over regulating the WSPs and there is duplication of responsibilities with WSBs and the MoWI (WSP, 2011). WASREB prosecuting powers have never been fully exercised (WSP, 2011). After the devolution of power the WSBs took administrative responsibility for most assets formally belonging to the MoWI, but have not yet received the deeds of ownership.

Under the pending National Water Bill (2014) there will be significant institutional changes. Nakuru County Government will gain ownership of water and sanitation assets, but will license them to the WSPs. Nakuru County can be held accountable if the Water Bill is not enforced. This creates a conflict of interest as they will own and regulate these assets. When the Water Bill is enacted, it will initially run alongside the Water Act, creating a dual regulatory regime that could cause confusion and conflict between county and national government.

Spending on sanitation is difficult to assess, as budgets are not easily disaggregated (Washwatch, 2013). WSTF capital recently dropped by 14%, partly due to the stabilisation of the Kenyan Shilling (WSTF, 2013). The water sector in Kenya is mainly funded by the government, through levies and investment from development partners. Householders are expected to cover the hardware, operation and maintenance costs. A majority of the sanitation software budget pays the salaries of the environmental health workers, but it is unclear what percentage of their time is dedicated to sanitation (WSP, 2011).

Private sector investment in sanitation dates back to 1996 (PPP Unit, 2013). The government has strengthened the legal and regulatory framework to increase private sector involvement.

The monitoring and evaluation cycle in the Kenyan water and sanitation sector emulates a project management cycle. WASREB currently monitors and evaluates the performance of the WSBs and WSPs through gathering, collating and disseminating data in their annual *Impact Report*.

There are only five parameters which directly relate to sanitation. Only sanitation coverage was reported on in the latest Impact Report (WASREB, 2014). Effluent quality is not a parameter which is reported on for the Impact Reports, although the WSPs report their effluent quality results to WASREB on a monthly and annual basis as required under the Environmental Management and Co-ordination (Water Quality) Regulations 2006. All of the above monitoring is for offsite sanitation, very little monitoring occurs of the onsite sanitation service chain. This is possibly due to the policy gap mentioned above, as no ministry regulates onsite urban sanitation.

5. Service outcomes

Nakuru has a diverse technology landscape which includes two sewage treatment plants (STPs) and a number of onsite technologies. The data used to generate the SFD were from KNBS (2010) as they came from the only recent large data set which covered the entire town together with the latest offsite sanitation coverage figures from WASREB (2014)

An area of 13km^2 of Nakuru is sewered (Gacheiya & Mutua, 2009). For preparing the SFD the sewer system was considered to be combined system with a leakage rate of 20%. The percentage of the population using this network was thought to be 28% (WASREB, 2014). Old Town STP mainly receives domestic wastewater and faecal sludge, whereas Njoro STP principally receives industrial wastewater. Both STPs are operating under their design capacity.

At Old Town STP there is a 55% loss of volume across the process, which is attributed to evaporation and seepage. No current monitoring data were obtained from NAWASSCO. The effluent discharge standards are set by NEMA at 30mg/l BOD, 15mg/l SS and 50 mg/l COD (Nguta & Kulecho, 2011). Samples taken after the facultative and maturation ponds almost met these standards, but after tertiary treatment the effluent quality decreased (Nguta & Kulecho, 2011). In terms of the SFD the proportion of the flow that evaporated is considered to be safely managed, as it no longer poses any risk to the population or the environment. The proportion of the flow that seeps into the ground is also considered to be safely managed, due to the depth to the water table being 8 meters (Nguta & Kulecho, 2011). The flow that is discharged into Lake Nakuru is also only partially treated (75%) as it does not meet the standards set (Nguta & Kulecho, 2011).No effluent is discharged from the Njoro STP due to evaporation and seepage.

The most common onsite sanitation technology type used is basic unlined pit latrines (57%), with a split of 39% and 18% between those that are manually emptied and those that are not. The majority are manually emptied, due to the lack of space to dig new pits. The faecal sludge from these pits is discharged into the local environment. The remainder of the basic latrines are either safely or unsafely abandoned. A small percent of the population use improved pit latrines (8%) which are emptied by vacuum tanker. 6% of the population use septic tanks, but only 1% actually function at septic tanks (with chambers and soakaways). The majority (the other 5%) are just sealed tanks. These are also emptied using vacuum tankers. Only 1% of the population practice open defecation.

A possible further contributor to excreta flow in Nakuru is school sanitation facilities. There were 190 schools in Nakuru town in 2007 and 65,811 students (Opendata 2015a,b). This was 21% of the population. The SFD does not include data from schools, as major assumptions are required to confirm how much these facilities are used.

It was estimated that there is a diurnal transient population made up of construction workers and students. It is estimated that they increase the population by 5% but, as little is known about the habits of these populations, the SFD was not adjusted to account for the increase in excreta from the transient population.

6. Overview of stakeholders

Nakuru Municipal Council is currently responsible for service provision and regulating sanitation.

Offsite sanitation is provided by Nakuru Water and Sanitation Services Company (NAWASSCO). NAWASSCO is owned by the local council and

regulated by the Rift Valley Water Service Board. Both the local council and the Rift Valley Water Service Board report to the Water Services Regulatory Board.

Onsite sanitation is regulated by NEMA and through local laws e.g. Nakuru County Public Health and Sanitation Bill. This is enforced at local level by environmental health officers.

There is public sector involvement in the emptying of onsite sanitation systems. There are four privately owned vacuum tankers operating in Nakuru (Pasteur& Prabhakaran, 2015). 37 manual emptiers were found to be working throughout Nakuru (Pasteur& Prabhakaran, 2015). Although the practice of manual emptying is currently illegal, Practical Action are currently trying to legitimise it (Pasteur& Prabhakaran, 2015).

There are many NGOs working in Nakuru town. These include; Practical Action, Umande Trust and WSUP.

7. Credibility of data

The SFD is based on the data from the 2009 census, triangulated through interviews and observations, and negotiated with key stakeholders.

The service delivery context has been developed through a literature review and from reviewing nationally important policies and plans available in the public domain.

8. Process of development

The fate of infiltrate from soakaways and pit latrines has been disregarded in the SFD. It was deemed to have little, if any, adverse impact on health or the local environment (through ground water pollution). Therefore it is considered to be safely managed. The SFD represents only the flows of wastewater and faecal sludge through the sanitation service chain.

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SFD Nakuru, Kenya, 2015

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Table of Content

Table of Content 1
List of tables 2
List of figures 2
Abbreviations 3
1 City context 4
1.1 Location 4
1.2 Population 5
1.3 Geography 6
1.4 Climate 8
2 Service delivery context description 8
2.1 National Policy 9
2.2 Local Policy 10
2.3 Institutional roles 11
2.4 Service provision 13
2.5 Service Standards 13
3 Service Outcomes 16
3.1 Offsite systems 16
3.2 Onsite systems 19
3.3 Usage 19
3.4 Categories of origin 22
3.4.1 Households 22
3.4.2 Shared or communal toilets 22
3.4.3 Public toilets 22
3.4.4 Nakuru Prison 22
3.4.5 Universities 22
3.4.6 Schools 22
3.4.7 Hospitals 23
3.4.8 Military Presence 23
3.4.9 Commercial areas and Industrial Zones 23
3.4.10 Tourism 24
3.5 Emptying technologies for onsite sanitation 24
3.5.1 Manual emptying 24
3.5.2 Motorised Emptying 25
3.6 End-use or disposal 26

3.7 Drinking water supplies in the town 26
4 SFD 26
5 Stakeholder Engagement 29
5.1 Key Informant Interviews 29
Acknowledgements 29
References 30
Appendix 1: Stakeholder identification 33
Appendix 2: Tracking of Engagement 34
Appendix 3: Details of hospitals in Nakuru and their numbers of beds 35
Appendix 4: Coverage of manual emptying 36
Appendix 5: Coverage of motorised emptying 37
Appendix 6: Final SFD 38

List of tables

Figure 1: The Municipal boundary of Nakuru Town and the three administrative divisions (Municipal Council of Nakuru, 2011) 4
Figure 2: The constituency boundary of Nakuru (Town West and East) 5
Figure 3: The location of LIA in Nakuru together with the water supply system (NAWASSCO, 2013) 6
Figure 4: Institutional roles and relationships in the water and sanitation sector in Kenya under the Water Act (2002) (WSP, 2011) 9
Figure 5: Monitoring and evaluation cycle in the Kenyan water sector (WSP, 2011) 14
Figure 6: Map of sewerage network in Nakuru (Umande & Practical Action, 2012) 17
Figure 7: Old Town Sewage Treatment Plant (NAWASSCO, 2015) 18
Figure 8: Map showing the location of sewer lines, wastewater treatment plants, CBD and factories in Nakuru 24

List of figures

Table 1: Landscape characteristics in Nakuru (LA21 Local Team, 1999) 8
Table 2: Key changes in institutions from those formed in the Water Act 2002 12
Table 3: Information required for the Water Regulation Information System (WARIS) which relate to sanitation (WASREB, 2007) 15
Table 4: Summary of the studies which have reported types and usage of sanitation system in Nakuru 21
Table 5: Table showing the data used to generate the SFD 28
Table 6: Details of unstructured interviews with stakeholders 29

Abbreviations

BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
CBD	Central Business District
DPHO	District Public Health Officers now known as Subcounty Public Health Officers
DWO	District Water Officer
ESAWAS	Eastern and Southern Africa Water and Sanitation
GDP	Gross Domestic Product
KNBS	Kenya National Bureau of Statistics
LAs	Local Authorities
LIA	Low Income Area
MDG	Millennium Development Goal
MoE	Ministry of Education
MoPHS	Ministry of Public Health and Sanitation
MoWI	Ministry of Water and Irrigation
NAWASSCO	Nakuru Water and Sanitation Services Company
NESHP	National Environmental Sanitation and Hygiene Policy
NMC	Nakuru Municipal Council
ROSA	Resource-Orientated Sanitation Concepts
SFD	Excreta Flow Diagram
STP	Sewage Treatment Plant
SUO	Sewer Use Ordinance
UBSUP	Upscaling Basic Sanitation for the Urban Poor
WARIS	Water Regulation Information System
WASREB	Water Services Regulatory Board
WSB	Water Service Board
WSTF	Water Service Trust Fund
WSP	Water Service Provider
WSP	Water and Sanitation Program
WSUP	Water and Sanitation for the Urban Poor

1 City context

1.1 Location

Nakuru is the fourth largest town in Kenya, it is located 160 km North West of the capital city Nairobi in the Rift Valley (Ojwando & Mutua, 2009). It lies at an average altitude of between 1,850 (NAWASSCO, 2013,) and 1,859 (Raude et al., 2009) metres above sea level. The town covers an area of between 270 km^2 (NAWASSCO, 2013) and 290 km^2 (Umande and Practical Action; 2012, Raude et al., 2009), but Lake Nakuru National Park occupies 188 km^2 leaving only 102 km^2 for the town (Raude et al., 2009). The town is sandwiched between the national park to the south and the Menengai volcanic crater in the north (Mwangi, 2003).

Nakuru's economy is driven by commerce, industry, agriculture (especially wheat) and tertiary services (Mwangi, 2003). Nakuru Town is classified as a municipality under the Urban Areas and City Act 2011 (as it has population > 250,000) (Nakuru County, 2013). It is divided into three administrative divisions, Municipality, Lanet and Barut, where a majority of the population live (Figure 1). Nakuru Town consists of two constituencies; Nakuru Town East and West Figure 2 (Nakuru County, 2013). The constituency boundaries extend beyond those of the Municipality (Figure 1 and Figure 2), hence the populations of the town and municipality differ. For the scope of this study the area covered is represented by the three administrative divisions within the town boundary (Figure1).

Figure 1: The Municipal boundary of Nakuru Town and the three administrative divisions (Municipal Council of Nakuru, 2011)

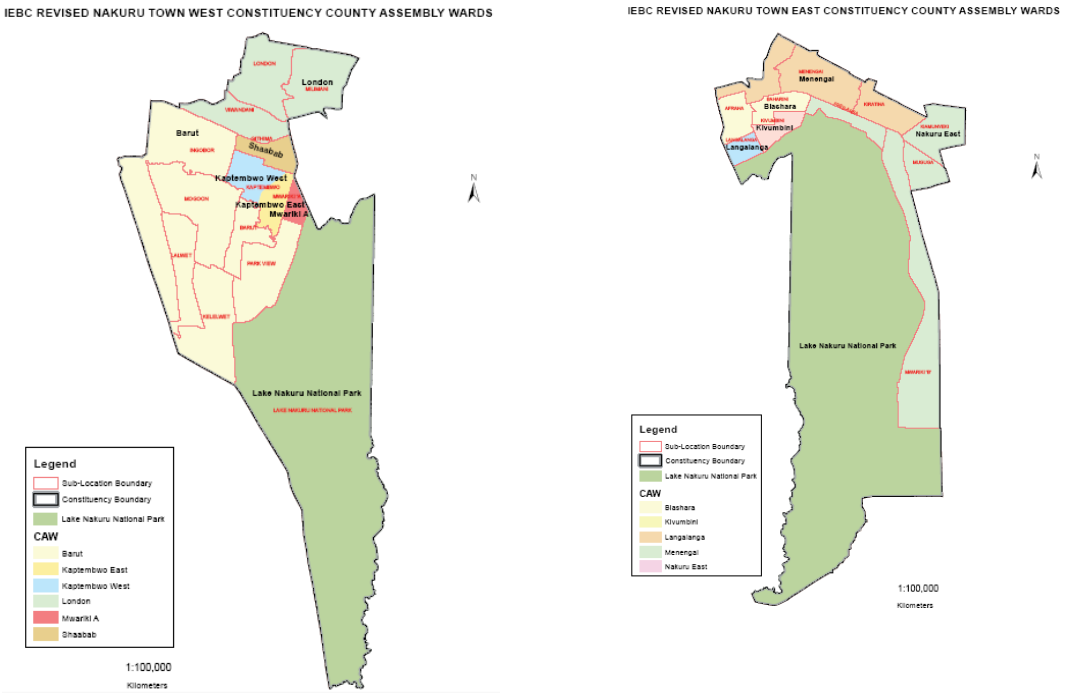


Figure 2: The constituency boundary of Nakuru (Town West and East)

(Madavadi, 2015)

1.2 Population

In the literature, the population of the Municipality of Nakuru ranges from 268,411 to over 500,000 (Gacheiya & Mutua 2009; KNBS, 2010a; Mwanzia & Misati, 2013; NAWASSCO, 2013, Raude et al., 2009; Umande & Practical Action, 2012). This is probably due to the different boundaries used. There are also huge variations in the population growth rates; ranging from 2.7% to 13% (City Population 2015; Mwanzia & Misati, 2013; NAWASSCO, 2013; Raude et al., 2009; Umande & Practical Action, 2012). For the scope of this study it was decided to use the projected population for Nakuru town for 2015 of 369,839, which is presented in the Nakuru County Development Plan (Nakuru County, 2013). It is estimated that over half of the population live in the town's 42 low income areas (LIAs) (Mwanzia & Misati, 2013; NAWASSCO, 2013) which occupy 50km^2 of the town (NAWASSCO, 2013). The LIAs are shaded green in Figure 3.

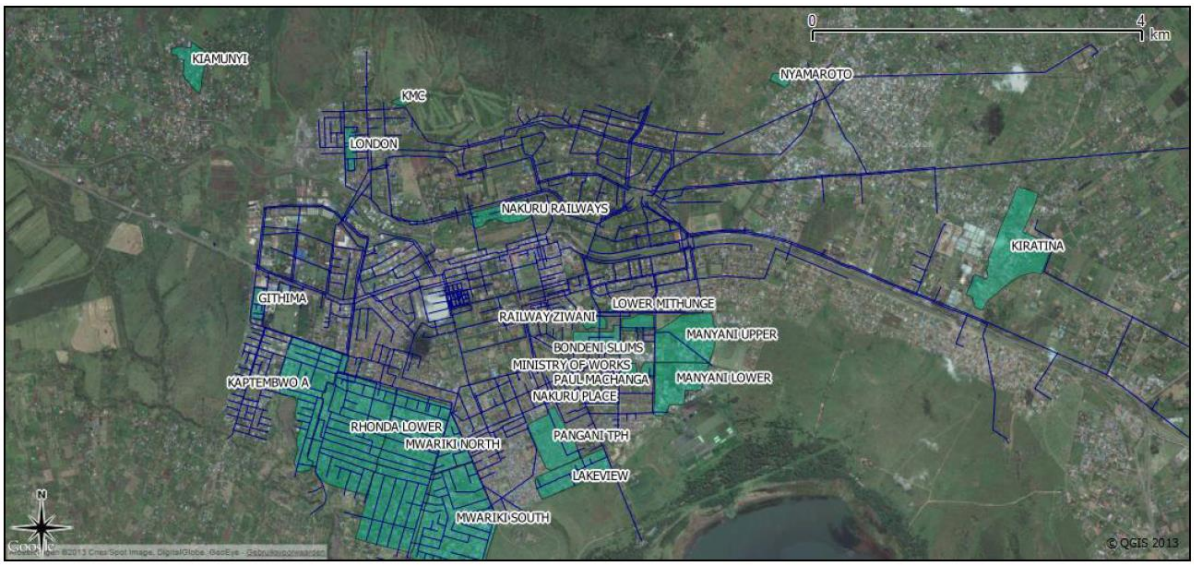


Figure 3: The location of LIA in Nakuru together with the water supply system (NAWASSCO, 2013)

Nakuru is a rapidly growing town and there are extensive construction projects which require support in the form of labour. It is also an educational hub and many students travel from outside the town to study. These activities lead to a diurnal variation in population which is estimated to be 5% (Ouko, 2015a). As little is known about these populations the SFD has not been adjusted. Nakuru is also a centre for wheat trading during May to June and November to December, which inflates the town's population during these periods, but these changes are thought to be insignificant when compared to the overall population of the town (Ouko, 2015a).

1.3 Geography

Nakuru Town (excluding the Megengai Crater slope, Bahati Forest and Lake Nakuru National Park) has been divided into three categories of landscape considering slope and drainage, as shown in

Table 1. In Nakuru town the soils are young, poorly developed, porous and pumiceous, derived from pyroclastic ejectamenta from the Megengai Crater and the Rift valley volcanic vents (Umande & Practical Action, 2012). There is very low run-off from these soils as their porous nature allows for direct percolation into the saturated zones (Mwangi, 2003; Umande & Practical Action, 2012). The soil is generally deep and well drained, but quite loose; excavations easily collapse during digging (Umande & Practical Action, 2012). A major geological fault zone passes through the town. It is located west of the central business district (CBD) and industrial zones, and passes through several LIAs (Mwangi, 2003; Umande & Practical Action, 2012). Nakuru town slopes steeply from the north (at 2100m) to the south (at 1750m) (Umande & Practical Action, 2012). This causes significant run-off during the rainy seasons, occasionally causing flooding to low lying areas such as Manyani, Rhonda and Kaptembwo (Umande & Practical Action, 2012). The water table depth varies from <20 m to 40 m (Table 1), but the depth of water in a majority of boreholes was found to range from 6 to 10 m (Alamirew et al., 2011).

Table 1: Landscape characteristics in Nakuru (LA21 Local Team, 1999)

Soil stability category	Slope (degrees)	Drainage	Soil depth and characteristics	Water table	Faulting etc.	Areas
Highly stable	0 - 2	Well drained	>180 cm	No data	Faulting only in the western tip	Old Town
Moderately stable	0 - 2	Well drained	>180 cm Surface rock coverage 0-25%	Low 20 to 40 m deep	Few incidences of faulting.	Kabatini, Dundori, Bahati and Elementaita
Low stability	No data	Mbaruk Valley: poorly drained	> 180 cm unstable and some areas of shallow soils <25cm	High water table in Rhonda <20m	High level of faulting (subsistence)	Kiamunyi, Rhonda, Baruti, Gichobo, Naishi, Mbaruk

1.4 Climate

The climate in Nakuru is mild, warm and temperate. It is classified as a Mediterranean climate with a dry summer (Köppen-Geiger classification Csb) (Climatedata, 2015). The average temperature is 17.5 °C and the average annual rainfall is 895 mm (Climatedata, 2015). There are two rainy seasons; the short one from November to December and the long one from March to May (Safaribookings, 2015).

2 Service delivery context description

The right to sanitation is entrenched in the Constitution of Kenya (2010) (WASREB, 2014) and the new medium term plan under the Societal Pillar in Vision 2030, which states …'every Kenyan should have access to clean safe water and improved sanitation by the year 2030,' (NAWASSCO, 2013).

The current policy, legislation and institutions in Kenya will be going through a transition period as the pending National Water Bill (2014) will soon be implemented; this will supersede the Water Act (2002). These laws dictate the institutional framework, including roles and responsibilities. The institutional system under the Water Act (2002) is shown in Figure 4. Due to the devolution of power the District Public Health Officers are now known as Subcounty Public Health Officers and school sanitation and hygiene promotion now falls within the remit of the Department of Health (King'ori, 2015b).

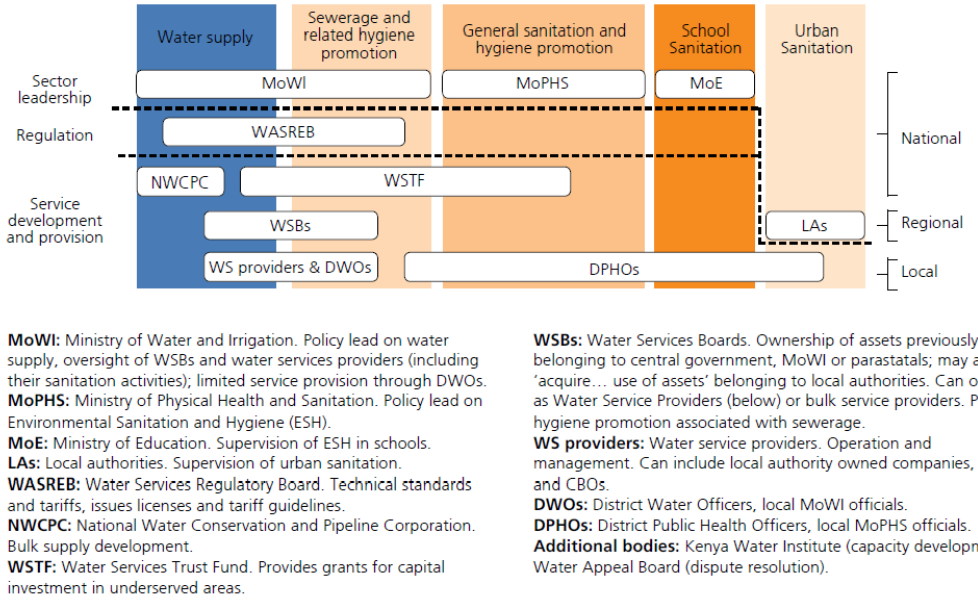


Figure 4: Institutional roles and relationships in the water and sanitation sector in Kenya under the Water Act (2002) (WSP, 2011)

2.1 National Policy

In Kenya the Ministry of Water and Irrigation (MoWI) is the policy forming institution in the water and sanitation sector. When the Ministry of Public Health and Sanitation (MoPHS) was established in 2008 and was given the remit for onsite sanitation in rural areas. MoWI focuses on sewerage systems (offsite sanitation), which are only found in urban areas (Pasteur & Prabhakaran, 2015). There is a policy gap due to this historical division of rural onsite vs urban offsite, as onsite urban sanitation and its associated service chain is not covered by either institution. It is regulated through policies from the National Environmental Management Authority (NEMA) i.e. Waste Management Regulations 2006. This regulation provides guidelines on waste (including excreta) transport, treatment and disposal. Additionally, the onsite sanitation service chain has been integrated at a county level in Nakuru in their draft Water Bill (2014).

The Water Act 2002 emerged from water reforms in Kenya, and this Act spearheads the establishment of the current institutional regulatory framework for water resources management, which includes water and sanitation service provision (only offsite in urban areas) and initiated the devolution of these services from the central government.

The National Environmental Sanitation and Hygiene Policy (NESHP) was produced in 2007 and the MoPHS is leading its implementation (Umande & Practical Action, 2012). The policy focuses on the coordination of stakeholders in the sanitation and hygiene sector in attaining the MDG target for sanitation (Umande & Practical Action, 2012). The aim of the policy is to increase household access to sustainable and functioning toilets to 90% by 2015 (Umande & Practical Action, 2012). It also targets schools, and reduction of preventable sanitation and hygiene related disease. A demand responsive

approach has been championed in NESHP, which led the MoPHS to formally recommend the use of this approach, including its use in urban areas (Umande & Practical Action, 2012). The aims of NESHP have been adopted locally in the Nakuru County Sanitation Program 2012-2016 (NAWASSCO, 2013). This program includes the development of large scale transport, emptying and treatment services, which include processing of faecal sludge (NAWASSCO, 2013).

The Public Health Act Cap. 242 empowers Public Health Officers (employed by MoPHS) to inspect and assess hygiene standards in all sectors (Umande & Practical Action, 2012). Under this law, the public is able to sue a private entity or local government that provides a waste management service, when they are not fulfilling their responsibility or causing a public nuisance e.g. burst sewers (Umande & Practical Action, 2012).

2.2 Local Policy

Nakuru Municipal Council (NMC) was formed under the Local Government Act Cap. 265. Under this Act the local government manage the development and provide services including sanitation (Umande & Practical Action, 2012). Through this Act, the authorities are able to contract service provisions to private entities through public private partnerships (PPPs), with the local authority ultimately ensuring standards of service and deliverables (Umande & Practical Action, 2012). With respect to sanitation this covers emptying services for onsite sanitation systems, and public sanitation service provision (Umande & Practical Action, 2012).

The pending National Water Bill aims to align the current law with the requirements of the constitution. This has been translated into county law through the draft Nakuru County Water Bill 2014. Within the draft County Bill the term 'water services' also encompasses the provision of sewerage. It states that an inter-sectoral approach should be taken on sewerage and faecal sludge treatment, and calls for the development of decentralised sanitation facilities (Nakuru Gazette Supplement, 2014). It states that NAWASSCO should collect, treat and manage wastewater and sludge *regardless of origin*, therefore giving them the role of managing the onsite sanitation service chain in the town (Nakuru Gazette Supplement, 2014). This goes beyond the pending National Water Bill, as it specifically includes the development of the onsite sanitation service chain. The draft County Bill also includes the formation of the Nakuru County Water Inspectorate who will enforce local water bylaws (Nakuru Gazette Supplement, 2014).

Like the draft County Water Bill, Nakuru's new County Public Health and Sanitation Bill (County Government of Nakuru, 2015) incorporates the whole sanitation service chain. This Bill highlights the roles and responsibilities Nakuru County's Public Health Department in regulating sanitation in the county. This Bill bans open defecation and the rental of properties without sanitation facilities. It states that all new buildings (including commercial buildings) must have approved sanitation facilities, for which the technology is considered to be for septic tanks where no sewer line exists. Approval must be sought from the County Government for the following:

- Building of septic tanks and other systems for treating or disposing of sewage
- Building of sludge treatment facilities
- Use of treated sludge other than agriculture

The County Government is responsible for the safe disposal of faecal sludge, and has a duty to provide decentralised wastewater and sludge treatment plants. For those with latrines it is the proprietor's responsibility to remove and safely dispose of sludge. It also covers the licensing of motorised emptiers (*exhausters*) including small systems to such as the Gulper (Section 3.2).

2.3 Institutional roles

As Kenya's water and sanitation sector is currently in a period of transition due the pending introduction of the National Water Bill in 2015, the institutions which are currently in place will soon become obsolete. Table 2 shows the current institutions alongside the pending new institutions. The current institutions were formed under the Water Act 2002, which included the formation of the independent regulator, the Water Services Regulatory Board (WSRB). Also under this Act, the ownership of assets was devolved to a regional level with the creation of Water Service Boards (WSBs) which then contracted them to Water Service Providers (WSPs). The current key institutional roles and their interaction in this sector can be seen in Figure 4.

In urban and peri-urban areas water and sanitation services are provided by WSPs which are publicly owned water companies, and which levy tariffs to generate revenue to meet their operational and maintenance costs. Nakuru Water and Sanitation Service Company (NAWASSCO) provides these services to urban residents within the municipality of Nakuru. WSBs delegate their legal responsibility to provide water and sanitation services to the WSPs, through service provision agreements. The WSBs' mandate is to develop water and sanitation assets as well as tariff regulation, and the Rift Valley Water Services Board serves Nakuru town. Both the WSPs and WSBs are regulated by the national Water Services Regulatory Board (WASREB). The regulator is mandated to ensure implementation of policies and strategies relating to water and sanitation nationally. It sets rules, enforces standards, and monitors the performance of WSPs and WSBs. In the urban sector the Water Services Trust Fund (WSTF) distributes funding for improving access to water and sanitation in LIAs, and WSPs can access these funds (WSP, 2011). These funds are being used to develop the onsite sanitation service chain through the Upscaling Basic Sanitation for the Urban Poor (UBSUP) program, which aims to develop and improve collection, transport and treatment of faecal sludge (WASREB, 2014).

Under this system WASREB does not have total authority over regulation. There is duplication of responsibilities, as the WSBs and MoWI also inspect, monitor and report on the performance of WSPs (WSP, 2011). Although WASREB has prosecuting powers, these powers have never been fully exercised (WSP, 2011). The WSBs took administrative responsibility for water and sanitation assets formerly belonging to the MoWI, but have not yet received the deeds of ownership.

The pending National Water Bill 2014 states that the county government is responsible for water supply, and that the licence for WSPs will be granted through them. In this Bill sanitation services includes wastewater from centralised (offsite) and decentralised (onsite) systems, but excludes household sanitation facilities. Household sanitation facilities are included in Nakuru County's draft Water Bill. Under the pending National Water Bill (2014) there will be significant institutional changes, which are highlighted in Table 2.

Table 2: Key changes in institutions from those formed in the Water Act 2002

Name of Institution		Roles and responsibilities' under the Water Bill 2014
Under the Water Act 2002	Under the Water Bill 2014	
Water Service Regulatory Board	Water Services Regulatory Authority	-To determine and prescribe national standards -To evaluate and set tariffs -To monitor and regulate the WSPs
Water Service Trust Fund	Water Sector Trust Fund	-Assist in financing water service in marginalized areas
Water Service Boards	Water Works Development Boards	-Technical assistant to WSPs and county governments -Hand over assets to the county WSPs
Water Appeals Board	Water Tribunal	-Dispute resolution

From Table 2 it can be seen that Nakuru County government will, under the pending Bill, gain ownership of water and sanitation assets, but will license them to the WSPs. This means that the Nakuru County can be held accountable if the Water Bill is not enforced. The main responsibility of the WSBs (which is to ensure delivery of water and sanitation services) will be devolved to the county government under the pending National Bill. Therefore the future of the WSBs as the Water Works Development Boards is not clear. The two options currently being discussed are, (i) merging them into a single national body or (ii) devolving them to county level. The draft Nakuru County Water Bill refers to the Nakuru County Water Inspectorate, which is not consistent with the pending National Bill and may lead to duplication of roles and responsibilities. Devolving the licensing of WSPs to the county government creates a conflict of interest as they will set-up, own and regulate them.

A peer review of the of the water services regulatory system was conducted by the Eastern and Southern African Water and Sanitation (ESAWAS) Regulators in 2014. In their view the National Government in Kenya has a duty to set standards, monitor and report on sector performance, which is not in current legislation (WASREB, 2014). ESAWAS also noted that the pending National Water Bill diminishes the effectiveness of water services regulation as the WSBs are retained in the form of Water Works Development Boards (Table 2), but there is no provision to regulate them (WASREB, 2014). When the National Water Bill is enacted, it will initially run alongside the Water Act. This will create a dual regulatory regime that could cause confusion and conflict between county and national government.

2.4 Service provision

Kenya is a signatory of the eThekwini Declaration and therefore should be spending 0.5% of its GDP on sanitation and hygiene (Washwatch, 2013). This is difficult to assess, as sector budgets are not easily disaggregated (Washwatch, 2013, WSP, 2011). The proposed public budget in the National Water Master Plan is under a third of what is required to meet the Vision 2030 goal for water and sanitation (WARSREB, 2014). Additional funding will be sought through private sector investment (WARSREB, 2014, WSP, 2011). The funds available through the WSTF have dropped by 14% (from 2011/2012 to 2012/2013), partly due to the stabilisation of the Kenyan Shilling (WSTF, 2013).

The water sector in Kenya is mainly funded by the government, through levies and investment from development partners. It is assumed that householders will cover a certain proportion of the hardware costs (5% for onsite sanitation and 100% for sewerage), but there is no government policy on this contribution (WSP, 2011). As with hardware, the operation and maintenance costs are expected to be covered by the user. For onsite sanitation this is being applied by the service providers through tariffs, as they strive for full cost recovery (WASREB, 2014, WSP, 2011). Cost recovery of the WSPs is monitored and reported yearly in WASREB Impact Reports. NAWASSCO almost reached full cost recovery in 2014 (WASREB, 2014).

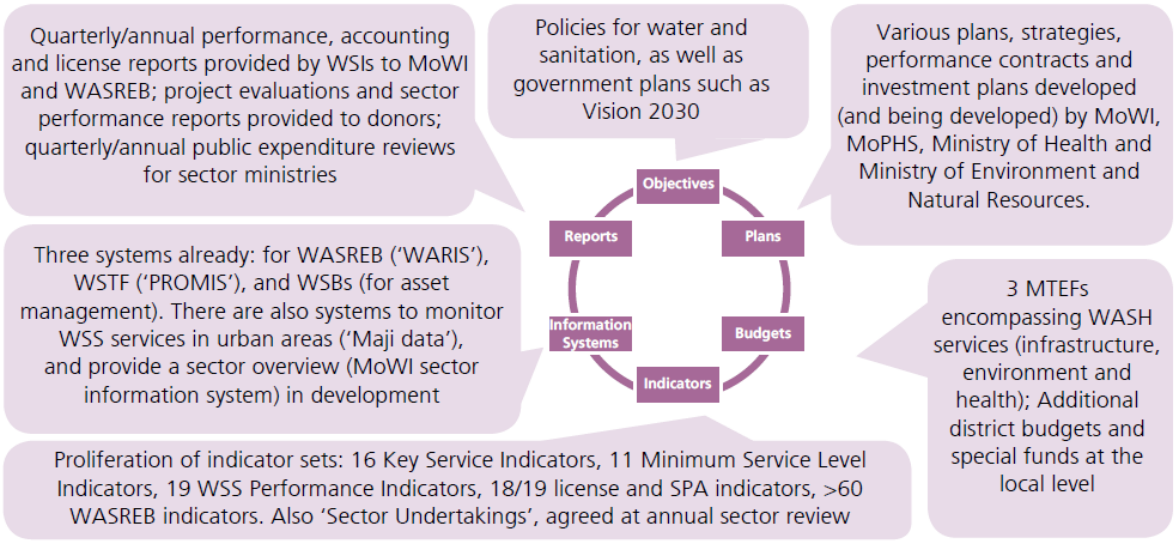
To safeguard public health the state has a responsibility to promote sanitation, but there is no policy, and it is unclear how this funded will be financed (WSP, 2011). A majority of the sanitation software budget pays the salaries of the environmental health workers employed by MoPHS. It is unclear what percentage of their time is dedicated to sanitation; additionally no specific budget is available for promotion materials (WSP, 2011).

Private sector investment in the water and sanitation sector dates back to 1996 (PPP Unit, 2013). To promote private sector participation, the Government of Kenya has adopted a Public Private Partner Framework (PPP Unit, 2013). Its aim is to improve the quality, quantity, cost-effectiveness and timely provision of much needed public infrastructure and services in Kenya. This has led to the strengthening of the legal and regulatory framework via the legislature below:

- PPP Policy statement (2011)
- Public Private Partnership Act, No. 15 (2013)
- The PPP Bill, No. 27 (2013)

2.5 Service Standards

Most of the sanitation standards set in Kenya relate to offsite sanitation, but they have been developing an integrated sector wide monitoring system since the enactment of the Water Act. The monitoring and evaluation cycle in the Kenyan water sector emulates a project management cycle (Figure 5). Objectives are set through policies and plans, which are then translated into strategies for which budgets are set. Indicators are then developed to monitor progress, data are collated via information systems, and reports are then published.



MTEFs = medium term expenditure frameworks

Figure 5: Monitoring and evaluation cycle in the Kenyan water sector (WSP, 2011)

As discussed in Section 2.3 WASREB currently monitors and evaluates the performance of the WSBs and WSPs through gathering, collating and disseminating data in their annual *Impact Report*. The Water Regulation Information System (WARIS) is the data collection tool that is used by WSPs (WASREB, 2014). Table 3 shows a description of the data collected by WASREB that relates to sanitation. Most of the reporting criteria listed in the guidelines relate to water, rather than sanitation, as water is seen as the main business of the WSPs (WASREB, 2007). There are only five parameters which directly relate to sanitation (shown in bold text in Table 3). In the most recent Impact Report, offsite sanitation (sewerage) coverage is the only sanitation parameter that is specified. There is no obligation for WSPs to report on effluent quality for WARIS, although it is reported to WASREB on a monthly and annual basis under the Environmental Management and Co-ordination (Water Quality) Regulations 2006. One of the major challenges with monitoring is caused by the differing quality of data submitted at various levels (WSP, 2011). Currently NAWASSCO is considered to be no-compliant as it does not conform to WASREB's governance standards (WASREB, 2014). As mentioned in Section 2.3.1 in the pending National Water Bill, the county governments will set-up, own and regulate the WSPs. This means that future standards will not be set independently.

Table 3: Information required for the Water Regulation Information System (WARIS) which relate to sanitation (WASREB, 2007)

Category	Parameter
General Information	• The number of board meetings during the reporting period • Objectives and achievements of the business and investment planning • Overview of service area including coverage
Financial Management	Legal obligation to provide financial statements which must include: • Revenue • Expenditure • Balance sheet • Profit or Loss • Cash flow and debt management • Investments and Financial sources
Commercial management	• Customer services and complaints • **Sewerage and sanitation (domestic, tanks and latrines)** • Billing and customer categories • Connection and reconnection details • Collection efficiency • **Sewer tariffs**
Technical information	• **Sewage treatment capacity** • **Volume of sewage treated** • **Sewerage network length**
Personnel information	• Staff composition • Number of staff per 1000 connections • Type of employment contract • Staff qualifications • Training measures • Accidents

Although industrial effluent is not included in this analysis, trade effluent discharged into the sewers systems requires a Sewer Use Ordinance (SUO) permit from the WSPs (under the Water Act 2002). This permit details the nature, composition and quantity of the waste discharged. Under this Act it is the industrialist's responsibility to implement a programme of self-monitoring guided by the SUO permit (WASREB, 2008). The industrialist must produce monthly and annual reports which are submitted to the WSPs and WSBs (WASREB, 2008). This means that industrial or trade waste entering the sewers and sewage treatment plant can be disaggregated from household sewage.

Within the sewage treatment plant (STP) samples are taken at several points: influent, effluent from the different processes, and the final effluent (WASREB, 2008). Each WSP must analyse the results of its influent and effluent samples to ensure compliance with the Kenyan Standards. WSPs must submit monthly and annual reports for each treatment works to the WSB and WASREB, and highlight any problems and corrective action taken (WASREB, 2008). WASREB are meant to publish the results annually in their Impact Report. This does not occur, and effluent quality is not included in the WARIS (see Table 3).

The standards for effluent discharged to the environment, and what parameters are monitored, are set in the Environmental Management and Co-ordination (Water Quality) Regulations 2006. A total of

49 parameters are listed in these regulations. Hotels, restaurants and lodges have to monitor 11 of these parameters, domestic sewage treatment systems have to monitor 12 and combined STPs have to monitor 42 (WASREB, 2008). In the latest Impact Report no data were published on the compliance of the WSPs to these regulations. In this report it was noted that most WSPs do have the laboratory resources to monitor drinking water quality (WASREB, 2008), therefore it is assumed that the effluent quality monitoring is not implemented at most STPs.

There is currently no systematic monitoring of the number or quality of household onsite sanitation systems in the urban sector (WSP, 2011). Monitoring and reporting on urban underserved areas remains poor (WSP, 2011), although it is improving. There is a clear lack of mandate on onsite sanitation, and WASREB currently relies on data from external sources such as the Department of Public Health results, although data on LIAS are now available via Maji Data.

Motorised empting and transport services (i.e. vacuum trucks) are licensed through WSPs, County Government and NEMA. WSPs monitor the discharges of faecal sludge at the sewage or sludge treatment plant (Section 3.5.2). Presently manual pit emptying is illegal under Kenyan law, although stakeholders in the sanitation sector in Nakuru are trying to address this. Due to their legal status manual emptiers are not licensed or monitored (Section 3.5.1).

3 Service Outcomes

There is a diverse technology landscape in Nakuru which includes two STPs and a number of onsite technologies, which are described in the subsequent section.

3.1 Offsite systems

A 13km^2 area of Nakuru is sewered (Gacheiya & Mutua, 2009). The sewers are located in high-income areas, shown in Figure 5. Due to problems with solid waste management in the town, many sewers are blocked and they are generally poorly maintained (NAWASSCO, 2013, Müller, 2014). The percentage of the population connected to the sewers is estimated to be between 14% and 28% (KNBS, 2010b, Nguta & Kulecho, 2011, Muchiri & Muelleger, 2009, Mwanzia & Misati 2013, WASREB, 2014). A leakage rate for the sewers could not be found, but a report from Nairobi noted their sewers had a 40% leakage rate in 2009 (Wikipedia, 2015a. (It should be noted the original report could not be accessed.). Evidence of leaks from the sewer system in Nakuru was found in the local media (Mobile Nation, 2015, Daily Nation, 2015, Nakuru County News, 2014). In the SFD the sewer system is considered to be a combined system with a leakage rate of 20%. The percentage of the population discharging their wastes to the sewer network was assumed to be 28%, which is the most recent data that was obtained (WARSEB, 2014).

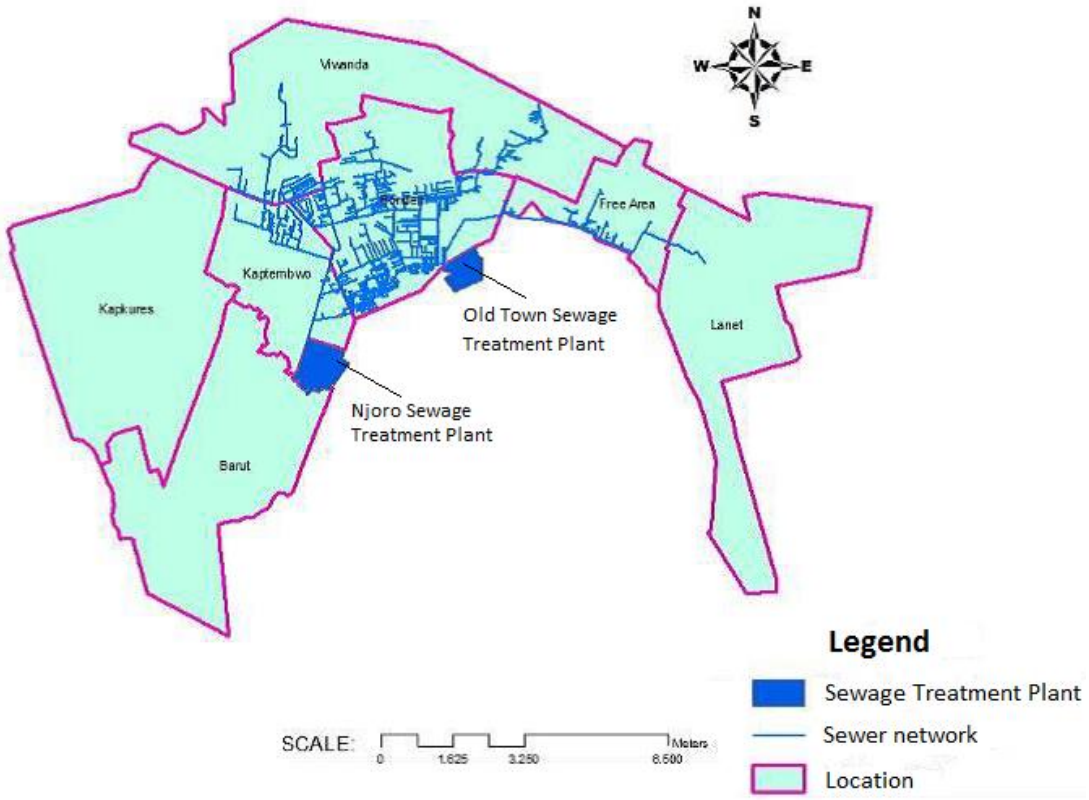


Figure 6: Map of sewerage network in Nakuru (Umande & Practical Action, 2012)

Nakuru has two STPs, Old Town and Njoro STPs (Figure 6). The Old Town STP is located in the National Park and was originally built in 1956, then modified in 1996 (NAWASSCO, 2015). The influent treated is 99% domestic and 1% industrial, and it also receives faecal sludge from motorised emptiers (Nguta & Kulecho, 2011, Rehema, 2015a). The average daily influent flow is between 3,800 and 4,500 m^3, but the plant has a capacity to treat 6,600 m^3 per day (NAWASSCO, 2015, Nguta & Kulecho, 2011), so it is operating under its design capacity. A schematic of the treatment processes can be seen in Figure 7. Additionally five vacuum tankers (motorised emptiers) deliver approximately 150m^3 of faecal sludge daily directly to the anaerobic digester (sludge digester, Figure 7) at the site (Ouko, 2015b). From the most recent data it was noted that 4,500 m^3 of sewage enters the treatment plant daily, but only 2,000m^3 of effluent is discharged into Lake Nakuru (NAWASSCO, 2015). There is a 55% loss of volume across the process; and in a previous report the loss was found to be 61% (Nguta & Kulecho, 2011). This 61% loss was attributed to evaporation (30%) and seepage (31%) (Nguta & Kulecho, 2011). In the current data it can be assumed that the loss via evaporation remains the same as the climate has not changed significantly, but the loss through seepage has been reduced.

No current monitoring data were obtained from NAWASSCO. Effluent discharge standards are set by NEMA at 30mg/l BOD, 15mg/l SS and 50 mg/l COD (Nguta & Kulecho, 2011). In a study published in 2011 it was found that samples taken after the facultative and maturation ponds (Figure 7) almost met these standards, but that after tertiary treatment (Figure 7) the effluent quality deteriorated (BOD=88mg, SS=178 mg/l COD=134mg/l) (Nguta & Kulecho, 2011). This deterioration in quality was attributed to damage of the tertiary treatment system by wild animals (Nguta & Kulecho, 2011).

In terms of the SFD the proportion of the flow that evaporated is considered to be safely managed, as it no longer poses any risk the population or the environment. The flow that seeps into the ground (approximately one-third of the influent) is also considered to be safely managed, due to the water table being at a depth of 8 m (Nguta & Kulecho, 2011). It is assumed that the seepage occurs from the facultative and maturation ponds and/or tertiary treatment stage (Figure 7). Hence it is partially treated and gains further treatment via interaction with soil microbes. The flow that is discharged into Lake Nakuru (also approximately one-third of the influent) is also only partially treated as it does not meet the effluent standards set (Nguta & Kulecho, 2011). The flow from the Old Town STP is considered to be partially treated (75%) for producing the SFD.

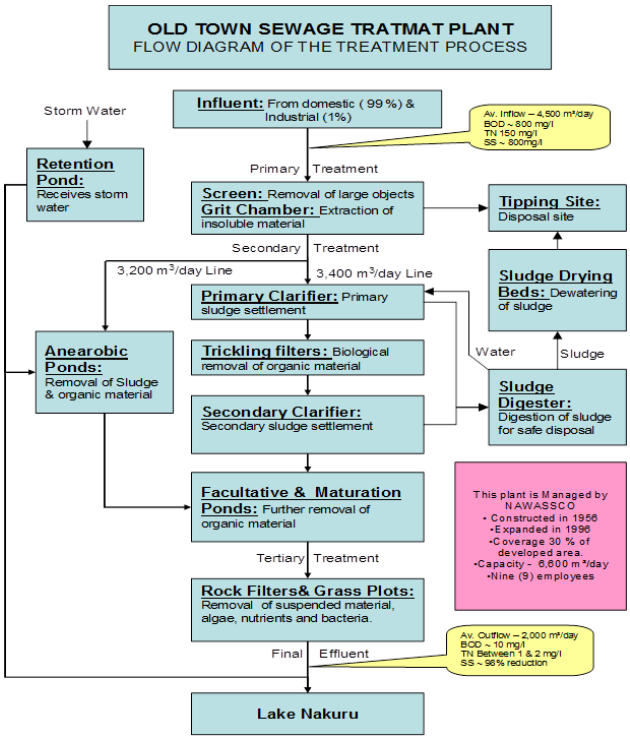


Figure 7: Old Town Sewage Treatment Plant (NAWASSCO, 2015)

Njoro STP is also located in the National Park and was originally built in the 1970s and was rehabilitated in the 1990s (Nguta & Kulecho, 2011). It was designed to take the effluent from industrial processes; hence the influent consists of 90% industrial and 10% domestic wastewater. It has a capacity to treat 9,600m^3 of influent per day (Nguta & Kulecho, 2011, Rehema, 2015a, Ouko, 2015c), but receives a daily average flow of 5,076 m^3 (Nguta & Kulecho, 2011). It is operating under its design capacity. The treatment processes are the same as in the Old Town STP (Nguta & Kulecho, 2011). Major losses across the process have been recorded, as 12% via evaporation and 88% via seepage, therefore no effluent is discharged into Lake Nakuru (Nguta & Kulecho, 2011). In terms of the SFD the domestic wastewater going through this system is considered to be treated, due to the assumptions listed previously. The ground water table level at this site is at a depth of 12 m (Nguta & Kulecho, 2011).

3.2 Onsite systems

There are many reports highlighting EcoSan in the town (Muchiri & Muelleger, 2009, Ojwando & Mutua, 2009) and one of the main objectives of NAWASSCO's Low Income Areas Action Plan is to increase EcoSan coverage, although only 25% of households opt for this technology (Rehema, 2015a). A report by the UBSUP team on the Resource-Orientated Sanitation Concepts (ROSA) Project found that only two out of the 20 EcoSan toilets constructed were still functioning after five years (UBSUP, 2013). NAWASSCO has learnt many lessons from the ROSA project, and is implementing urine diverting dry toilets in conjunction with a motorised emptying service (Rehema, 2015a,b). The waste or compost from these systems will then be taken to the Old Town STP for further processing (Rehema, 2015a,b). Through key informant interviews it is believed that there is a low coverage of EcoSan in the town (Ouko, 2015a, Murigir, 2015), therefore this technology is not included in the SFD.

The most common sanitation type in Nakuru is the basic or traditional latrine, these are unlined pits with varying super structures (Table 4). They are more prevalent in LIA (Table 4). In the past they were abandoned when full, due the unstable soil which causes the unlined pits to collapse when mechanically emptied (Murigir, 2015; Ouko, 2015a; Rehema, 2015b). Now it is thought that a majority of latrines are manually emptied, because there is a lack of space to re-dig pits (King'ori 2015a; Mugo, 2015; Pasteur & Prabhakaran, 2015). Manual emptiers are used due to their availability, price, ability to gain access to the pit area, and ability to empty the pit without it collapsing (Mugo, 2015.) The strategies used by manual emptiers are discussed in Section 3.5.1. Alternatively people dig extremely deep pits so they fill slowly. In terms of the SFD this technology is classified as unlined pits which are mainly emptied by manual means although some are abandoned once full (Table 5).

Improved latrines are semi-lined and have a vent pipe with varying super structures (Table 4). In terms of the SFD this technology is classified as lined pits with semi-permeable wall and open bottom with no outlet or overflow. As these pit are lined and located in middle class areas they are generally emptied by motorised means (Section 3.5.2). Septic tanks are also found in Kisumu (Table 4), these are found in middle and high income areas. Many of the septic tanks in Kisumu are known not to have soakaways and operate as sealed tanks, this is reflected in the data used to generate the SFD (Table 5). The proportion operating as sealed and septic tanks were negotiated with stakeholders. These systems are emptied by motorised means (Section 3.5.2).

Conservancy tanks are currently being trialled by NAWASSCO in LIAs (Rehema, 2015b). These are pour flush systems linked to sealed tanks that are emptied at intervals by a vacuum truck or gulper (Rehema, 2015b). This technology has not gone to scale, and is used by <1% of the population, so is not included in the SFD.

3.3 Usage

A summary studies which have reported the usage of different sanitation technologies across Nakuru Town can be seen in Table 4. Five of the seven data sets focus on LIAs, so they are not representative

of the town as a whole (Table 4). The only data set which includes data for the whole town (other than the data from KNBS) was authored by Muchiri & Muelleger (2009), but this has a small sample size (Table 4). Hence data obtained by KNBS, together with the most recent data on sewerage coverage (WASREB, 2014), were used to generate the SFD. The KNBS data was used because it was collected relatively recently, the data set covered the whole city not just the LIAs and it has a large same size (Table 4).

Table 4: Summary of the studies which have reported types and usage of sanitation system in Nakuru

Data source	NAWASSCO	Moseti et al.	Muchiri & Muelleger	KNBS	Majidata	Umade Trust & Practical	WASREB	WSUP	Data used for the SFD
Year	2007	2009	2009	2010b	2011	2012	2014	2014	2010/2014
Study area	All LIAs	2 unspecified LIAs	Unspecified across Nakuru	Nakuru & Nakuru North	All LIAs	Kaptembwo & Rhonda (LIAs)	Nakuru Town	All LIAs	WASREB & KNBS
Sample size	estimated	100	215	115,418	2,379	3,250	population	1,178	population
Basic pit latrines	51%[1]	46%	49%	61%	44%	63%	N/A	31%	57%
Improved latrines including VIP latrines	10%	13%	14%	9%	29%	31%	N/A	10%	8%
Sewered	N/A	15%	16%	22%	N/A	3%	28%	19%	28%
Pour flush to leach pit[2]	N/A	5%	6%	N/A	N/A	1%	N/A	N/A	N/A
Septic tank	12%	11%	12%	7%	2%	2%	N/A	2%	6%
Open defecation	N/A	N/A	3%	<1	1%	2%	N/A	N/A	1%
Other	27%	10%	N/A	<1	1%	N/A	N/A	4%	N/A
Communal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	34%	N/A

[1] 51% ordinary pit latrine or pour flush to leach pit

[2] the introduction to of leach pits was encouraged to reduce pit latrine filling (Pasteur & Prabhakaran, 2015).

3.4 Categories of origin

3.4.1 Households

As the average household size is four (Umande & Practical Action, 2012) and the current population is 369,839 (Nakuru County, 2013), there are an estimated total of 92,459 (= 369,839 ÷ 4) households in the town.

3.4.2 Shared or communal toilets

Shared sanitation is defined by UNICEF as sanitation shared by two or more households (UNICEF, 2015). From a baseline survey of 3,250 households in two low-income areas (Kaptembwo and Rhonda) it was found that 84% of households were sharing sanitation facilities with between four and more than ten households (Umande Trust and Practical Action, 2012). The data were not disaggregated below the level of one to three households. From this data it can be seen that in LIAs a majority of households (84%) are using shared sanitation facilities.

3.4.3 Public toilets

In Nakuru public toilets are used less than in other parts of Kenya, due to land tenure issues (Ebrahim, 2015). This is supported by low awareness of facilities available in LIAs (Umande Trust & Practical Action, 2012). There are ten public toilets in Nakuru including one located in Soko Mjinga village, and another at the central market in Rhonda (King'ori 2015b; Pasteur & Prabhakaran, 2015; Umande Trust & Practical Action, 2012). Due to the low awareness of these types of sanitation options in LIAs it can be assumed that they do not significantly contribute to the excreta flow in the town.

3.4.4 Nakuru Prison

Nakuru prison holds approximately 1,500 prisoners (Dissel, 2001). Prisoners are included in the census data about prisoners will already be included in the SFD.

3.4.5 Universities

Nakuru is an educational hub, with more than fifteen universities and university campuses within its municipal boundaries (King'oir, 2015b). University students living in Nakuru town will be counted in the national census (Ouko, 2015a). The universities in Nakuru have small campuses i.e. buildings or parts of buildings in the town centre (identified via Google maps). They are located in areas which are connected to the sewers, and it is therefore assumed that waste generated from these campuses goes into the sewerage system.

3.4.6 Schools

There were 128 primary (Opendata, 2015a) and 59 secondary schools (Opendata, 2015b) classified as being in Nakuru Town/Municipality in 2007. Of the primary schools 68 are private (Opendata, 20 15a). There are 53,151 students attending these primary schools, and within the schools there are 1,768 toilets (287 for staff and 1,481 for students) (Opendata, 2015a). Of the secondary schools in the town a majority are private (40) (Opendata, 2015b). In 2007 there were 12,660 secondary pupils, but the number of toilets was not recorded in the secondary school data set (Opendata, 2015b).

The total number of students studying in 2007 was 65,811, was approximately 21% of the population at the time. If it is assumed that 21% of the current population are attending school, this means there are currently 77,666 pupils in the town. It is assumed that pupils defecate at home either before or after school, and therefore the SFD is not adjusted to account for this flow. If this assumption is correct, and the school excreta flow was included, each pupil would be counted twice in the SFD, once at home and once at school. To include the flow of excreta from schools a better knowledge of the use of school and home sanitation facilities is required, so usage could be split between locations. It is noted that this is potentially a huge excreta flow, if the facilities are used for defecation by a high percentage of pupils.

3.4.7 Hospitals

A total of 19 hospitals or residential medical centres were identified within the boundary of the town of Nakuru, there details can be found in Appendix 1. Together the hospitals have 1,030 beds and 184 cots, this represents <1% of the population hence this data is not included in the SFD analysis.

3.4.8 Military Presence

The 1st Kenya Rifles and the 3rd Kenya Rifles are based in Nakuru County, but the main barracks is ten km from the town (Wikipedia, 2015b). The location of the barracks is therefore outside the area considered for this study.

3.4.9 Commercial areas and Industrial Zones

The Central Business District (CBD) is a distinct zone in the town (Figure 8). It is found in the historical heart of the town which is sewered. Therefore it is assumed that sewage generated from this area will be accounted for in the amount received and treated at the Old Town STP (Section 3.2). The town's industrial zone is located directly west of the CBD. This area is also sewered, and the wastewater from this zone is received at Njoro STP (Section 3.2)

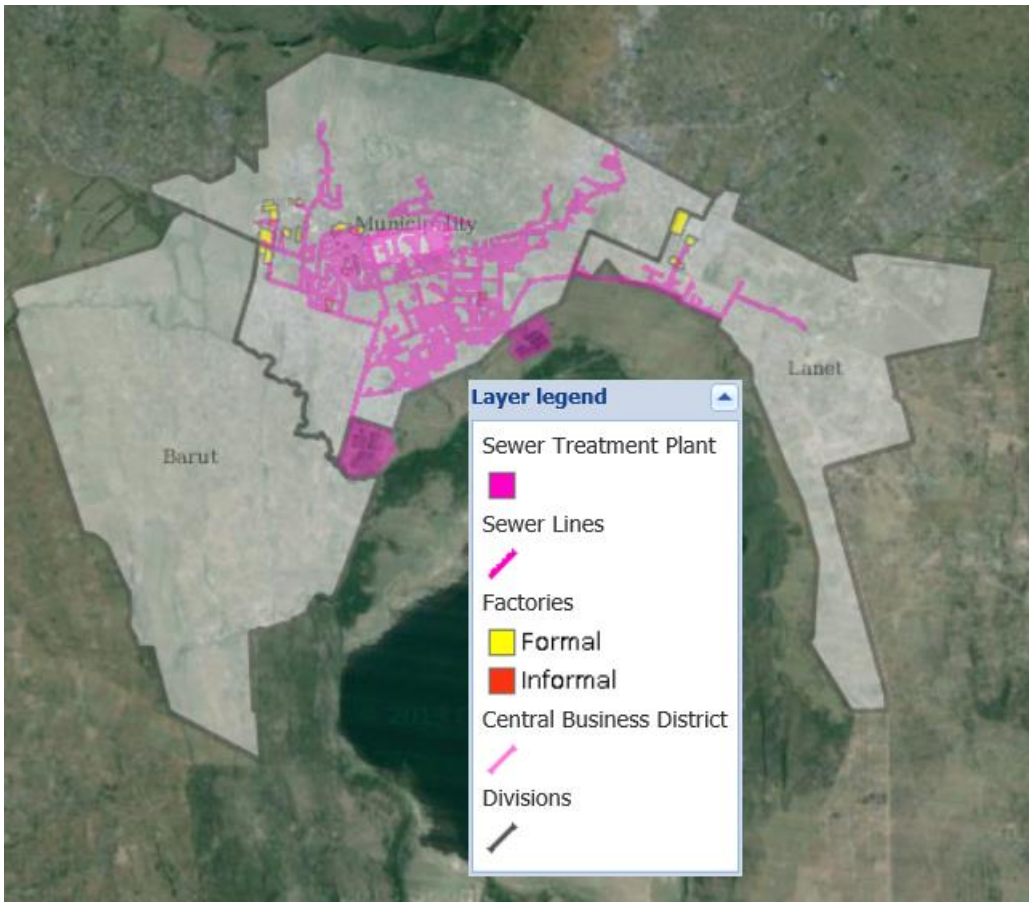


Figure 8: Map showing the location of sewer lines, wastewater treatment plants, CBD and factories in Nakuru

Generated through http://nakinfo.unibe.ch/nakinfo.html

3.4.10 Tourism

Lake Nakuru National Park is one of Kenya's most popular domestic and international tourist attractions. Visitor numbers peaked in 2007 at 346,800, according to the Ministry of Tourism (Kenyaology, 2015). If it is assumed that each of these visitors stays two days in Nakuru Town, the town's population is increased by 1,900 people annually. This is <1% of the current population, therefore the SFD has not been adjusted to account for this. It is also assumed that the excreta from restaurants is insignificant, this is due to the predominant habit of people defecating in the morning and evening. If data flows from restaurants were to be based on the numbers of diners, it would lead to these flows being counted twice, once at their place of residence and again at the restaurant.

3.5 Emptying technologies for onsite sanitation

3.5.1 Manual emptying

There are 37 manual emptiers working in Nakuru (Pasteur & Prabhakaran, 2015), and their role is not formally recognised. They work town-wide and mainly at night, due to the taboo associated with handling human waste (Pasteur & Prabhakaran, 2015). As the practice of manual emptying is illegal,

there is no formal place for the faecal sludge to be discharged, so it is dumped in the local environment, either in an uncovered pit or open drain (Murigir, 2015; Rehema, 2015). Four strategies of emptying and disposing of the waste have been identified in Nakuru:

- Puncturing the side of the pit and letting the faecal sludge flood out from the side of the pit
- Empting and burying the faecal sludge in a pit either inside or outside the plot
- Empting the pit and disposing of the faecal sludge in sewers
- Empting the pit and disposing of the faecal sludge in the environment (Mugo, 2015)

It has been estimated that 39% of the population of Nakuru are served by manual emptiers (Appendix 4). The assumptions in the SFD reflect the fact that manual emptiers almost exclusively empty pit latrines (King'ori, 2015a; Mugo, 2015) (Table 5). The majority of the faecal sludge from the methods listed above gets returned to the local environment, which is acknowledged in Table 5.

Practical Action, Umande Trust and NAWASSCO are presently working with the manual emptiers to train them, and to legitimise their activity. The manual emptiers are now organised into an official association to aid lobbying on these issues. Through lobbying, the Gulper (a small motorised emptying system normally housed on a motorcycle, developed by Water for People in Uganda) is now an accepted technology under the Nakuru County's Public Health and Sanitation Bill 2015. The association of manual emptiers has raised the funds to buy two Gulpers to use in LIS. These will be managed collectively and be approved by the MoH and NAWASSCO. The operators will be given a licence to operate and discharge by NAWASSCO (NAWASSCO, 2013, Pasteur & Prabhakaran, 2015).

Under NAWASSCO's LIAs strategy they are trialling transfer stations (primary collection points) which are to be used by manual emptiers and those operating the Gulper. They presently have one which has a capacity of 14m^3, but are planning to serve all LIAs (Rehema, 2015a,b). Each transfer station is estimated to have a capacity for 12-15 days' worth of waste. Once full it will be emptied by vacuum tanker. The sludge is then taken to Old Town STP (Rehema, 2015a).

3.5.2 Motorised Emptying

Motorised emptiers are known as vacuum tankers. This is a relatively expensive means of emptying a system (KSh 4,000-5,000 per trip). Due to their size of the vehicles they cannot access the plots where most pit latrines are based. It has previously been stated (section 3.2) that they will not empty unlined pits due to soil instability and the fear of blocking the pipes with debris (Pasteur & Prabhakaran, 2015). Therefore, motorised empting is used almost exclusively for emptying septic tanks, lined pits and large sanitation systems i.e. schools, hospitals, hotels etc. (Mugo, 2015). Motorised emptiers are required to have a permit from NAWASSCO. Currently there are five licensed operators in Nakuru (Pasteur & Prabhakaran, 2015; Ouko, 2015c). One is owned by NAWASSCO and four are privately owned (Müller, 2014). The faecal sludge from these systems is taken to the Old Town STP.

It has been estimated that 13% of the population of Nakuru town are served by motorised emptiers (Appendix 5). It is further assumed that they are emptying either septic tanks or improved latrines.

3.6 End-use or disposal

NAWASSCO has a MOU with Egerton University to produce products from faecal sludge, compost and urine. Currently they are piloting struvite, compost and biofuel (briquettes) production (Rehema, 2015a). A 240m^3 biodigester is currently being constructed at Old Town STP, which will receive faecal sludge from onsite sanitation systems and convert it into biogas (Rehema, 2015a). As the biodigester has not yet been completed, and the other technologies are at the prototype stage, they have not been included in the SFD.

3.7 Drinking water supplies in the town

NAWASSCO abstracts 80% of its water from boreholes and 20% from surface water (NAWASSCO, 2013). The ground water has a high fluoride level; therefore surface water is used to dilute it (NAWASSCO, 2013). Approximately 80% of the population of Nakuru obtain its drinking water supply from some kind of piped source (KNBS, 2010b). The NAWASSCO water coverage was assumed to be 93% in 2014 (WASREB, 2014). It is assumed that this water is treated to the standards set out in Kenyan law and therefore, within the scope of this study, sanitation in the town is not seen to pose a threat to drinking water quality.

In terms of generating the risk of ground water pollution from sanitation sources for the SFD the fractured rock was assumed for the rock type in the unsaturated zone (Section 1.3), and a conservative estimate of the depth to the stabilised water table is thought to be between 5 to 10 meters (Section 1.3). It is estimated that < 25% of sanitation facilities are <10 meters from ground water sources, but > 25% of sanitation facilities are uphill of groundwater sources. This is due to the gradient of the town (Section 1.3). Few ground water sources are used for providing drinking water in Nakuru (see above) so it is estimated that between 1 and 25% of drinking water is produced from ground water. Using these data a low ground water pollution risk was generated by the SFD matrix.

4 SFD

The data from Section 3 has been collated in Table 5. The assumptions made were negotiated and agreed upon with stakeholders (King'ori, 2015a; Kulecho, 2015; Mugo 2015; Okuo, 2015). These data were used to generate the SFD found in the Executive Summary and Appendix 6.

The percentage of waste delivered by the sewer network and the partial treatment of sewerage at the STPs is explained in Section 3.2. The use of 90% for the emptying percentage for improved pit latrines, septic and sealed tanks, is due to no options reaching 100%, and this was then checked by the calculations in Appendix 4. This assumption draws on the fact the motorised emptiers will generally not empty basic latrines (Section 3.5). Once a pit or tank has been emptied, it was assumed that 90% of this faecal sludge is delivered to Old Town Sewage Treatment Plant (Section 3.1). The use

of 39% for the percentage of basic pit latrines manually emptied is explored in Appendix 5. This draws on the assumption that manual emptiers almost exclusively empty pit latrines, and most of the manual methods used reintroduce the faecal sludge into the environment (Section 5.3.1). The other disposal routes for the faecal sludge acknowledged that some gets reburied either safely or unsafely (Table 5). All of these figures were agreed by stakeholders (King'ori, 2015a; Kulecho, 2015; Mugo 2015; Okuo, 2015).

The tool has the ability to take into account the flow of infiltrate from soakaways and pit latrines, but as this stream was deemed to be safely managed (Section 3.7), it was felt it could be disregarded in Nakuru. This was done to reflect the sanitation service chain more accurately in terms of faecal sludge movement.

Table 5: Table showing the data used to generate the SFD

KNBS 2010	%	Sub division	How defined in SFD	How emptied	Emptied (%)	Going to treatment (%)	Treated (%)	Notes
Open defecation	1		Open defecation	-	-	-	-	
Sewered (WASREB, 2014)	28		Centralised foul sewer – combined sewer	-	-	80	75	Combined due to leakages 80% delivered due to leakages
Basic pit latrines	57	39	Unlined pit with no outlet no overflow	Manually	100	0	0	39% emptied and discharged into environment
		9	Pit never emptied, abandoned when full and covered in soil		-	-	-	9% safely abandoned and covered in soil
		9	Pit never emptied abandoned when full not adequately covered in soil		-	-	-	9% unsafely abandoned
Improved pit latrines (i.e. VIP latrine	8		Lined pit with semi permeable walls open bottom with no outlet no overflow	Motorised	90	90	75	90% emptied via tanker and discharged at the STP
Septic tanks	6	5	Sealed tank with no outlet no overflow	Motorised	90	90	75	6% are not septic tanks, but sealed tanks which are emptied by tanker 90% of waste gets taken to STP
		1	Septic Tank outlet to soakway	Motorised	90	90	75	1% septic tanks and 90% goes to STP

5 Stakeholder Engagement

Permission to undertake this research was gained from the Mr Samwel King'ori the Nakuru County Public Health Officer. The primary stakeholder in this process was WSUP represented by Mr Samwel Ouko, and WSUP are our collaborative partners in this project. Additionally we have worked with Practical Action which manages a number of programmes in Nakuru. Stakeholders were identified via a snowball approach i.e. one stakeholder putting us in contact with another stakeholder etc. This approach was relatively successful, but time consuming.

5.1 Key Informant Interviews

Unstructured key informant interviews held are listed in Table 6, which also shows the topic covered. Interviews were undertaken after initial electronic engagement, and further details and additional clarifications were gained through continuing these dialogues after the interviews.

Table 6: Details of unstructured interviews with stakeholders

Key informants	Role	Topics covered
Mr Samwel Ouko	Project Officer – WSUP Kenya	Introduction to the sector, answering specific questions to fill knowledge gaps, negotiating assumptions
Mr Kariuki Mugo	Country Programme Manager - WSUP Kenya	Answering specific questions to fill knowledge gaps, negotiating assumptions
Mr Peter Murigir	East Africa Region Officer – Practical Action	Questions on Practical Action's Baseline Report , activities undertaken in Nakuru and answering specific questions to fill knowledge gaps
Mr Andrew Kulecho	Laboratory Manager - NAWASSCO	Questions relating to the sewage treatment plants and effluent quality, negotiating assumptions
Ms Zantuni Rehema	LIAs Officer - NAWASSCO	LIA action plan details and progress
Ms Aidah Ebrahim	Director of Umande Trust	Umande Trust's programmes in Nakuru
Mr Samuel King'ori	Nukuru County Public Health Officer	Questions on Nakuru Pubic Health Bill, questions on pit latrine emptying and negotiating assumptions

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Appendix 1: Stakeholder identification

Name of organisation	Name of contact person	Position	Source of contact	Influence (high/medium/low)	Interest (high/medium/low)
County Public Health Officer	Mr Samuel King'ori	County Public Health Officer	Rebecca	High	High
Egerton Unviersity	Mr Edward Muchiri	Lecturer	Rebecca	Medium	Low
KNBS - Nirobi	Mr Mutua Kakinyi	Director of KNBS	Mr Samwel Ouko	Medium	Low
NAWASSCO	Ms Zaituni Rehema	LIA project officer	Mr Samwel Ouko	High	Medium
NAWASSCO	Eng James Ng'ang'a	MD of NAWASSCO	Ms Zaituni Rehema	High	Low
NAWASSCO	Mr Andrew Kulecho	Laboratory Manager	Mr Samwel Ouko	Medium	High
Practical Action	Mr Peter Murigir	East Africa Region Officer	Rebecca	High	High
Practical Action	Mr Alexis Morcrette	Programme Coordinator for Urban Services	Mr Georges Mikhael	Medium	High
Practical Action	Ms Lucy Stevens	Senior Policy and Practice Adviser	Rebecca	Medium	Medium
Umande Trust	Ms Aida Ebrahim	Director of Umande Trust	Mr Peter Murigir	Medium	Medium
WSUP	Mr Kariuki Mugo	Country Director of WSUP	Rebecca	High	High
WSUP	Mr Shadrack Ondiech	Project Officer	Rebecca	Left WSUP	Left WSUP
WSUP	Mr Georges Mikhael	Head of Sanitation	Rebecca	High	Medium
WSUP	Mr Samwel Ouko	Project Officer	Mr Kariuki Mugo	High	Medium

Appendix 2: Tracking of Engagement

Comment: List stakeholder that was directly engaged in the study. For desk-based assessment through Email or Phone. For field-based assessment through the corresponding data collection method	Date of Engagement	Purpose of Engagement	Maximum 100 word summary of outcomes
Samwel Kingori	02/01/2015	Sent email	Trying to gain official permission to undertake the study in Nakuru
SK, KM, SO, GM	13/03/2015	Introduction to method	Claire sent introduction email about method and data collection, asking for a date and time for an initial phone call
Mr Georges Mikhael	04/05/2015	Introduction of Claire	Introductory email
Mr Kariuki Mugo	04/05/2015	Introduction of Claire	Introductory email
Samwel King'ori	04/05/2015	Introduction of Claire	Introductory email
Mr Shadrack Ondiech	04/05/2015	Introduction of Claire	Introductory email
Alexis Morcrette	15/05/2015	Intro' to project	Set a date for a skype
Samwel Ouko	15/05/2015	Setting date for first meeting	Date set for 28th May
Lucy Stevens	18/05/2015	Knowledge on activities	Sent me practical action report
Samwel Ouko	22/05/2015	Email data sources	Sam sent extra data about Nakuru
Samwel Ouko	27/05/2015	Kick of engagement meeting	Email to set time
Peter Murigi	29/05/2015	Emailed about CLTS report	Trying to set-up a call esp. about emptying services
Samwel Ouko	29/05/2015	Kick of engagement meeting	Called to explained the project and discussed kind of support you need
Edward Muchiri	01/06/2015	Introductory email -Ecosan	Emailed to start dialogue
Alexis Morcrette	02/06/2015	Email	Highlighting background on their projects and their SFD
Peter Murigi	02/06/2015	Email - questions	Sent a list of data gaps from literature review
Samwel Ouko	02/06/2015	Email - questions	Sent a list of data gaps from literature review
Peter Murigi	03/06/2015	Kick of engagement meeting	Spoke with about project and explained what we are doing, sent him a list of questions about Nakuru, he sent a reply 4/6/15 with answers and also asking about contracts and funding. Replied to that email 9/6/15.
Samwel Ouko	05/06/2015	Call about questions etc.	This call was changed to 10/6/15 went through each question, suggested I update Samuel Kingori of progress to gain permission for study, also was going to set up a call with the water company
Samwel Ouko	10/06/2015	Call about data gaps	
Samwel King'ori	16/06/2015	Sent calling card	Sent update - trying to establish dialogue
Samwel Ouko	02/07/2015	Sent email	Trying to get an interview with people in NAWASSCO
KNBS	06/07/2015	Email population data	Trying to establish the official population of Nakuru
Samwel Ouko	06/07/2015	Email update	Highlighting data gaps
Zaituni Rehema	09/07/2015	Email introduction	Introduction and setting up a time for a call
Eng James Ng'ang'a	13/07/2015	Email introduction to project	Introduction to project and asking for help with data collection
KNBS	13/07/2015	Email population data	Trying to establish the official population of Nakuru
Peter Murigi	13/07/2015	Email School Sanitation	Emailed to find out more about Practical Actions schools sanitation programs
Peter Murigi	13/07/2015	Reply	PA no school sanitation program, sent contact to Aida Brahim from Umande Trust
Samwel King'ori	13/07/2015	Email update	Email update on the progress made and highlighting future phases
Samwel Ouko	13/07/2015	Email update	Email update on what I have been doing
Aidah Brahim	14/07/2015	Emailed questions	Questions about Umande Trusts work in Nakuru including Bio Latrines
Nakuru branch of KNBS	14/07/2015	Email about population data	Trying to establish the official population of Nakuru, same days with a link to a report
Zaituni Rehema	14/07/2015	Interview Zaituni	Main topic pro-poor programs
Aidah Brahim	15/07/2015	Reply	Setting up of interview
Samwel Ouko	15/07/2015	Email update	Update on current gaps
Samwel Ouko	15/07/2015	Email clarification	Clarifying name of a hospital
Aidah Brahim	16/07/2015	Interview with Aidah	Interview about the Umande program in Nakuru - followed by an email containing my notes
Eng James Ng'ang'a	16/07/2015	Email for interview	Trying to establish contact, sent areas that I am interested in finding out about
Eng James Ng'ang'a	16/07/2015	Follow up email	Trying to establish contact
Aidah Brahim	21/07/2015	Email about notes	Trying to clarify points
Nakuru branch of KNBS	21/07/2015	Email for population data	Emailed about official growth rate
Zaituni Rehema	21/07/2015	Email about notes	Trying to clarify points
Zaituni Rehema	23/07/2015	Reply	With clarification on details from the interview
Nakuru branch of KNBS	04/08/2015	Email for population data	Emailed about official growth rate & sanitation breakdown in Nakuru
Samwel Ouko	05/08/2015	Email update	Emailed Samwel with update of progress
Samwel Ouko	07/08/2015	Emailed draft	Emailed draft and list of gaps in the data
Samwel Ouko	11/08/2015	Reply	Samwel replied
Samwel Ouko	11/08/2015	Skype	Review of data gaps
Samwel Ouko	12/08/2015	Reply	Samwel sent population stats after visiting KNBS - Nakuru
Mr Kakinyi	13/08/2015	Email	Asking for clarity on population
Mr Kakinyi	03/09/2015	Reply	Data from census - did not understand coding emailed for clarity 7/9/15
Samwel Ouko	07/09/2015	Email draft SFD	Sent draft SFD with explanation
Zaituni Rehema	07/09/2015	Trying to gain further interviews	Explaining why it would be good to have more interviews with NAWASSCO
Samwel Ouko	09/09/2015	Email to arrange a skype	Skype to discuss SFD and data gaps
Zaituni Rehema	11/09/2015	Email to SFD	With explanation and why I need to collect more data from NAWASSCO
Samwel Ouko	15/09/2015	Reply	Data from visit to NAWASSCO
Samwel Ouko	18/09/2015	Reply data from STP	Data collected from STP
Samwel Ouko	24/09/2015	Message	Data on STP in Nakuru
Samwel Ouko	01/10/2015	Emailed second draft of SFD	With assumptions, need a skype to agree assumption
Samwel Ouko	07/10/2015	Email reply	Feed back on the origonal report
Zaituni Rehema	09/10/2015	Email	Sent draft SFD and report for comment
Eng James Ng'ang'a	09/10/2015	Email	Sent draft SFD and report for comment
Samuel King'ori	09/10/2015	Email	Sent draft SFD and report for comment
Kariuki Mugo	09/10/2015	Email	Sent draft SFD and report for comment
Kariuki Mugo	26/10/2015	Email reply	Comments on draft
Kariuki Mugo	02/11/2015	Email	To clarify some points in the email
Samuel King'ori	02/11/2015	Email	Asking for feedback
Kariuki Mugo	05/11/2015	Call	To clarfiy some points and to gain an insight into emptying
Samuel King'ori	09/11/2015	Emailed	Wrong King'ori
Kariuki Mugo	10/11/2015	Call	About pit emtpying
Samuel King'ori	12/11/2015	Emailed	Public health bill
Samuel King'ori	13/11/2015	Reply	Figures for SFD approved
Andrew Kulecho	17/11/2015	Emailed	Emailed full report for comment
Samuel King'ori	17/11/2015	Call	Clarified some points to do with the STP
Samuel King'ori	24/11/2015	Emailed	Follow up about full report
Samuel King'ori	30/11/2015	Reply	Details of a contact in NAWASSCO

Appendix 3: Details of hospitals in Nakuru and their numbers of beds

Data was obtained from Ehealth, 2015.

Hospital	Number of beds	Number of cots
Afrah Maternity and Nursing Home	10	6
AIC Parkview dispensary	3	1
Annex Hospital	60	22
Bakaka Maternity Home	25	12
Bondeni Maternity	20	12
Crater Medical Centre	25	17
Evans Sunrise Medical Centre	75	0
Kimsaw Medical Clinic	8	0
Lanet Health Centre	10	6
Mediheal Hospital	20	4
Mother Kevin dispensary	24	1
Nakuru Nursing home	24	15
Nakuru Provincial General Hospital	588	68
Nakuru War Memorial Hospital	36	12
Nakuru West (PECA) Health Centre	7	1
PCEA Upendo Health Centre	3	0
Rapha Maternity Clinic	8	2
St Elizabeth Nursing home	12	5
Valley Hospital	72	0

Appendix 4: Coverage of manual emptying

Assumptions from data and experience:

- There are 37 manual emptiers working in Nakuru
- Manual emptiers work in teams of 3 to 12 people
- The teams empty one pit latrine per night
- The teams work approximately 300 days per year
- Average household size is 4
- Average number of households sharing a latrine is 10 (as found in LIAs)
- The population of Nakuru is 369, 839

Number of toilets emptied per year:

12 × 300 = 3,600 toilets per year

Number of people using the toilets:

3,600 × (4 × 10) = 144,000 people

As a percentage of the population:

(144,000 ÷ 369, 839) × 100 = 39%

Therefore it is assumed that 39% of those using pit latrines also use manual empting (Tables 4 and 5).

Appendix 5: Coverage of motorised emptying

Assumptions from data and experience:

- 150m^3 is delivered to Old Town Sewage Treatment Plant
- Average size of vacuum tanker 6.5 m^3
- It is assumed that all tankers are full
- A toilet is emptied in one trip
- 33% of trips are from institutions i.e. schools etc.
- Vacuum tanker operators work 5 days per week
- Average household size is 4
- Number of households sharing a toilet is 3 (due to higher income)
- The population of Nakuru is 369, 839

Number of toilets emptied per year:

(150 ÷ 6.5) × 260 = 6,000 toilets per year

6,000 × 0.67 = 4,020 household toilets emptied per year

Number of people using the toilets:

4,020 × (4 × 3) = 48,240 people using the toilets

As a percentage of the population:

(48,240 ÷ 369, 839) × 100 = 13%

Therefore it is assumed that all septic tanks (6%) and VIP latrines (8%) are emptied by motorised emptiers (Tables 4 and 5).

Appendix 6: Final SFD