SFD Promotion Initiative

Kampala
Uganda

Final Report

This SFD Report was prepared through desk-based research by Sandec (the Department of Sanitation, Water and Solid Waste for Development) at Eawag (the Swiss Federal Institute of Aquatic Science and Technology) as part of the SFD Promotion Initiative.

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Collaborating partners

water for people

Date of production: 06.06.2016

Last update: 11.07.2016

SFD Promotion Initiative

SFD Report Kampala, Uganda, 2016

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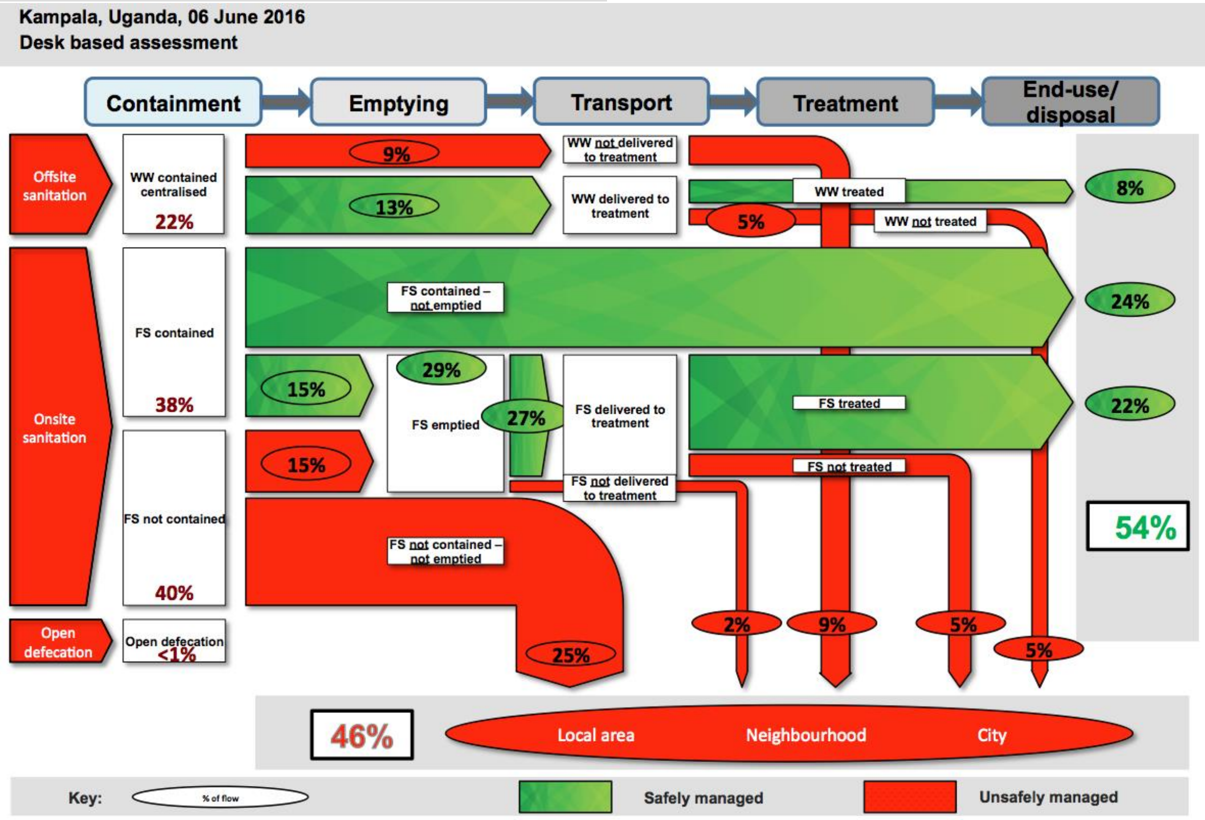
1. The Diagram



Note: Percentages do not add up to 100 due to rounding

2. Diagram information

The Shit Flow Diagram (SFD) was developed through desk-based research by Sandec (Sanitation, Water and Solid Waste for Development) of Eawag (the Swiss Federal Institute of Aquatic Science and Technology) and CEDAT (College of Engineering, Design Art and Technology) at Makerere University.

Collaborating partners:

Kampala Capital City Authority (KCCA)

National Water and Sewerage Corporation (NWSC)

Water for People, Uganda

Status:

Final SFD.

Date of production:

06/06/2016

3. General city information

Kampala is the capital and most populated city in Uganda, with a population of 1,507,080 (UBOS, 2016). The total area of the city is 178 km^2. The climate is tropical with two relative dry seasons between December and March, and June and July (KSMP, 2004).

64% of the city is classified as residential area. Wakiso and Mukono Districts surround Kampala and have a population of 1,997,418 (Wakiso) and 596,804 (Mukono) (UBOS, 2016). It is estimated that the population doubles during the day due to commuters from these areas (KSP, 2008, Kulabako et al., 2010). In line with rapid urbanization, approximately 60% of city residents live in informal low-income settlements (“slums”), which cover 10.8% of the city area (Günther et al., 2011), of which 95% lie in valleys (KII1, 2015).

The boundaries of Kampala and its five divisions (Central, Kawempe, Makindye, Nakawa, Rubaga) serve as the basis for the SFD assessment. To account for the large number of daily commuters into Kampala, the assessment is based on a total population of 2,25 million, including 1.5 million residents and 750,000 population equivalents to account for excreta from commuters during the time they are in Kampala (KSP, 2008, Kulabako et al., 2010).

4. Service delivery context

The implementation of water, sanitation and hygiene (WASH) activities in Uganda is governed by national policies, laws (acts) and regulations. In Figure 1, the institutional links between the most relevant institutions for sanitation service delivery are presented.

At the national level, the Ministry of Environment (MWE) is responsible for overall coordination, policy formulation, setting of standards, inspection, monitoring, technical back-up and initiating legislation. The Directorate of Water Development (DWD), Directorate of Environmental Affairs (DEA) and the Directorate of Water Resources Management (DWRM) are part of the MWE.

The National Environment Management Authority (NEMA) is directly linked to the MWE and is partly responsible for licensing all private businesses that are dealing with waste. This includes domestic waste, as well as industrial, chemical and construction waste.

Relevant policies related to the MoH, include the National Health Policy (1999, revised in 2012) and the Environmental Health Policy (2005), which sets out the environmental health priorities of the Government as well as providing a framework for the development of services together with programs at national and local government levels. Furthermore, the MoH provided guidance for the implementation of the National Water Policy (1999), established by the MWE.

The Ministry of Education, Science, Technology and Sports (MoESTS) is responsible for school latrine construction and public health (hygiene) education in schools. The MoESTS prepared a National Strategy for Girls' Education (NSGE), which is related to the National Gender Policy (1997) emphasizing the government's commitment to gender responsive development as part of the Constitution of Uganda (1995).

The National Water and Sewerage Corporation Act states that the National Water and Sewerage Corporation (NWSC) shall operate and provide water and sewerage services in areas entrusted under the Water Act (1995). These areas include 165 towns in Uganda, including Kampala. This document provides clear responsibility of sewer network operation, maintenance and expansion, and wastewater treatment to NWSC. As part of the responsibility for sewerage services, NWSC is also responsible for operation and maintenance of the Lubigi wastewater and faecal sludge treatment plant, commissioned in 2014. NWSC maintains low fees for discharge of faecal sludge at treatment plants, which is an incentive for legal discharge. Illegal discharge by private emptying service providers was not identified in Kampala.

The Kampala Capital City Authority (KCCA) was established under the KCCA Act (2010) by the Ugandan Parliament as a legal entity that replaced the former Kampala City Council (KCC). The act gives responsibility to KCCA to devolve functions and services to division urban councils. KCCA is partially responsible for sanitation infrastructure, which includes non-sewered access to sanitation in Kampala. KCCA is partly responsible for licensing of private businesses dealing with waste. KCCA has installed and maintains public toilet facilities, and provides some emptying and transportation of faecal sludge with five trucks in the five different divisions of Kampala, mainly serving schools, public toilets and to some extent, households in low-income areas.

While the policy, legislative and regulatory framework includes mandates for the provision of sanitation infrastructure and treatment, there is a gap in the regulatory framework for how faecal sludge should be emptied, collected and transported. The Private Emptiers' Association (PEA) was registered in 1999 and is a self-organized trade association for privately owned businesses. Private entrepreneurs that are registered with the PEA in general receive collective representation. In 2015, another organization was formed, the Kampala Private Emptiers' Association (KPEA), and so now there are two. There are currently businesses with a total of 85 trucks that belong to both organizations (KII3, 2016). NWSC provides space for the PEA at the newly constructed Lubigi Faecal Sludge and wastewater treatment plant, while the KPEA is based at the Bugolobi wastewater treatment plant (Schoebitz et al., submitted).

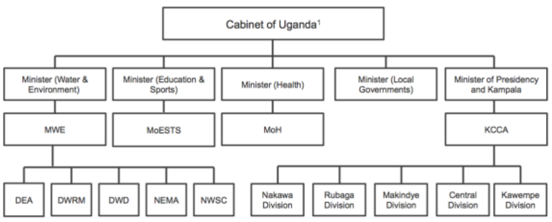


Figure 1: Institutional links for important stakeholders in Kampala (adapted from KSP (2008))

5. Service outcomes

In Kampala, 92.5% of residents are served by onsite sanitation technologies, which are either pit latrines or septic tanks. 7.5% of the population use flush toilets connected to piped sewers, which is more common in high-income and industrial, institutional and commercial areas (e.g. Central Division) (KSP, 2008).

In addition to the above mentioned 85 vacuum trucks operated as private businesses, KCCA also owns twelve vacuum trucks. Six of those are used for surveillance/maintenance of the sewerage network. The other six are used for faecal sludge collection and transport for hospitals, markets, schools, community and shared toilet facilities (operated by KCCA), private households and the commercial sector.

In areas with high population density and narrow roads, vacuum trucks cannot access containment technologies. In 2014, there were around 15 private entrepreneurs using the Gulper for collection and transport, supported by Water for People (WfP, 2015). The collected faecal sludge is transferred in 200L barrels with pick-up trucks to the Lubigi wastewater and faecal sludge treatment plant. The number of informal manual emptying service providers is not known. Faecal sludge emptied by the informal sector is typically directly dumped in the nearby neighbourhood, either into a hole they dig, or into storm water channels (Tsinda et al., 2015). There are currently five wastewater treatment plants in operation in Kampala. Four of them are designed for wastewater only, and one has faecal sludge and wastewater treatment plant in parallel. The total capacity for wastewater treatment is 39,175 m^3/d and 400 m^3/d for faecal sludge treatment (KSP, 2008). Dewatered faecal sludge and wastewater sludge, which have further been dried, are currently stored at the Lubigi and Bugolobi treatment plants. However, attempts are being made to promote the use of sludge for resource recovery including public private partnership agreements through NWSC to provide private entrepreneurs with dewatered faecal sludge.

The parameters influencing the risk of groundwater pollution were assessed for low-income areas and informal settlements, and for middle- and high-income areas. For low-income areas and informal settlements, the risk for groundwater pollution is significant. Low-income households are often located in valleys, where the groundwater table is high. Sanitation facilities are located close to drinking water sources, and the percentage of drinking water produced from groundwater sources is high. For medium- and high-income areas, a low risk for groundwater pollution exists, which is the result of a depth to the groundwater table of more than 10 m and sanitation facilities being located further than 10 m from groundwater sources (KII1, 2015).

In total, it was estimated that 48% of excreta in Kampala is safely managed. Containment technologies in medium- and high-income areas contain faecal sludge due to an identified low risk of groundwater pollution. The faecal sludge that remains in containment and is not emptied contributes 24% to the total percentage. Faecal sludge emptied by mechanical emptying service providers and manual emptying service providers using the gulper was found to always reach treatment and the total amount of faecal sludge treated contributes 22%. Wastewater treated safely contributes another 2% to the overall outcome of 48% safely managed.

As explained in detail in the report, for this SFD 46% of the total excreta at the time of writing was estimated to be unsafely managed. 25% of this is due to faecal sludge not contained and not emptied, which is prevalent in low-income and informal settlements. Faecal sludge emptied by manual emptying service providers, operating in the informal sector does not reach treatment and contributes 2% to the total percentage. An estimated 200 m^3/d faecal sludge is discharged at the Bugolobi wastewater treatment plant, which until the refurbishment is complete will contribute to 5% of faecal sludge not considered treated. Furthermore, it is estimated that 9% of wastewater does not reach treatment, due to blockages and overflows in the sewer network, and another 5% of wastewater is not treated, although it arrives at the Bugolobi wastewater treatment plant, due to the current operating conditions, it was considered to be 50% treated due to overloading of solids, organics and nutrients from faecal sludge discharge.

Less than 1% of the Kampala residents practice open defecation (Günther et al., 2011).

6. Overview of stakeholders

All relevant stakeholders are described under “4. Service delivery context”.

7. Credibility of data

The quality of available data was generally ranked high. The Kampala Sanitation Master Plan (2004) and the Kampala Sanitation Program (2008) provided an excellent source of background information for the service delivery context description as well as the service outcomes.

Seven peer reviewed journal articles served as data sources that were published between 2010 and 2015, in addition to research results that are in preparation for publication.

Information was available along the entire sanitation service chain.

Key informant interviews were used for any missing information on technical details of containment construction and performance of treatment infrastructure. In the future, the importance of groundwater pollution due to infiltration of excreta could be improved with more detailed information.

8. Process of SFD development

The SFD was developed in consultation with project collaborators and local experts in the field of urban sanitation in Kampala. Key assumptions were reviewed and confirmed. A draft SFD was produced and shared with relevant stakeholders. One revision was prepared based on a round of comments by collaborators.

9. List of data sources

GÜNTHER, I., HORST, A., LÜTHI, C. & MOSLER, H.-J. 2011. Where do Kampala's poor "go"? - Urban sanitation conditions in Kampala's low-income areas. *Munich Personal RePEc Archive*.

KII1 2015. Interview (phone call) with Stakeholder 1 (as described in Appendix 1 and Appendix 2).

KII3 2016. Comments on draft from Stakeholder 5 (as described in Appendix 1 and Appendix 2).

KSMP 2004. Beller Consult, Mott MacDonald, M&E Associates, Sanitation Strategy and Master Plan for Kampala City.

KSP 2008. Fichtner Water and Transportation, Kampala Sanitation Program.

KULABAKO, R. N., NALUBEGA, M., WOZEI, E. & THUNVIK, R. 2010. Environmental health practices, constraints and possible interventions in peri-urban settlements in developing countries - A review of Kampala, Uganda. *International Journal of Environmental Health Research,* 20**,** 231-257.

SCHOEBITZ, L., BISCHOFF, F., LOHRI, C. R., NIWAGABA, C., SIBER, R. & STRANDE, L. submitted. GIS analysis and optimization of faecal sludge logistics at city-wide scale in Kampala, Uganda

TSINDA, A., ABBOTT, P. & CHENOWETH, J. 2015. Sanitation markets in urban informal settlements of East Africa. *Habitat International,* 49**,** 21-29.

UBOS 2016. The National Population and Housing Census 2014 - Main Report. Uganda Bureau of Statistics.

WFP 2015. Water for People - Faecal sludge volumes emptied and collected by Gulper Businesses in Kampala, Uganda.

SFD Kampala, Uganda, 2016

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Abbreviations

AEE	African Enterprise
CIDI	Community Integrated Development Initiatives
DEA	Directrorate of Environmental Affairs
DWD	Directorate of Water Development
DWRM	Directorate of Water Resource Management
JMP	Join Monitoring Programme
JWESSP	Joint Water and Environment Sector Support Programme
KCC	Kampala City Council
KCCA	Kampala Capital City Authority
KfW	German Development Bank
KII	Key Informant Interview
KPEA	Kampala Private Emptiers' Association
KSMP	Kampala Sanitation Master Plan
KSP	Kampala Sanitation Program
MoESTS	Ministry of Education and Sports
MoH	Ministry of Health
MoU	Memorandum of Understanding
MWE	Ministry of Water and Environment
NDP	National Development Plan
NEMA	National Environmental Management Agency
NFA	National Forestry Authority
NGO	non-governmental organization
NPA	National Planning Authority
NSGE	National Strategy for Girls' Education
NWSC	National Water and Sewerage Corporation
PEA	Private Emptiers' Association
SFD	Shit-Flow-Diagram
UBOS	Ugandan Bureau of Statistics
UGX	Ugandan Shilling
USD	US Dollar
VIP	Ventilated Improved Pit
WASH	Water, Sanitation and Hygiene
WfP	Water for People
WHO	World Health Organization

1 City context

Kampala is the capital and most populated city in Uganda, with a population of 1,507,080 in 2014 (UBOS, 2016). The total area of the city is 178 km^2. The climate is tropical with two relative dry seasons between December and March, and between June and July (see Figure 2). Both periods, however, are frequently interrupted by thunderstorms and lead to heavy rain falls with an annual mean rainfall of 1293 mm (KSMP, 2004).

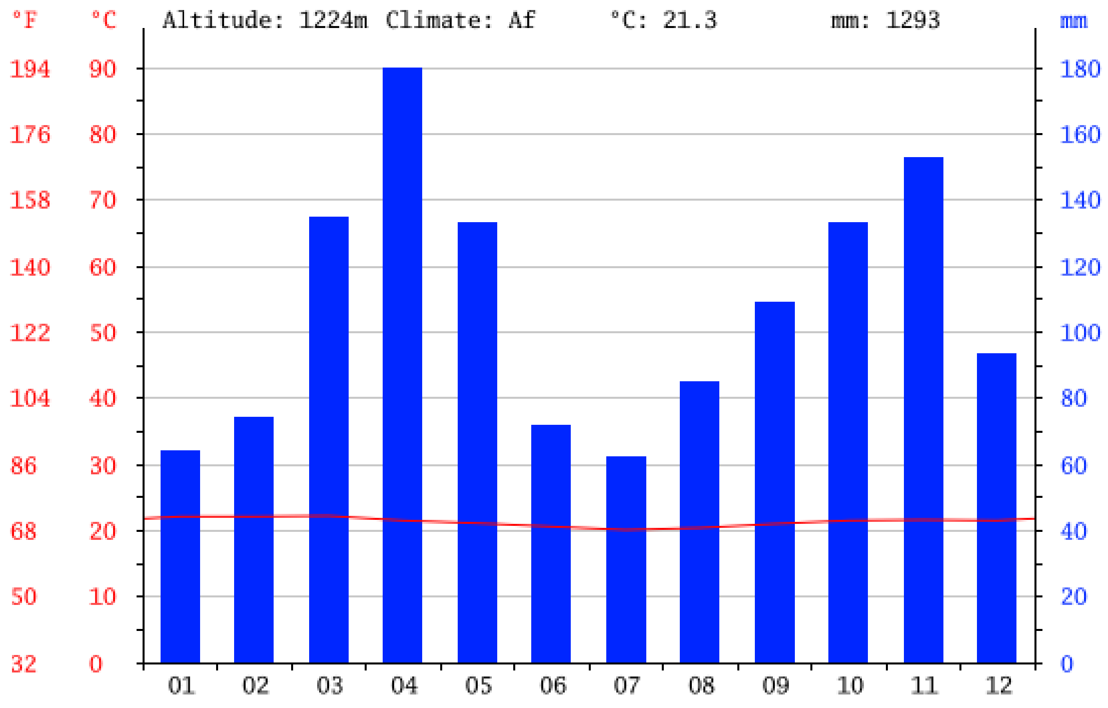

Figure 2: Climate diagram for Kampala, Uganda average temperature in red, rainfall in blue (climate-data.org, accessed 28.04.2016)

The city of Kampala has five municipal Divisions (Central, Makindye, Rubaga, Kawempe, Nakawa), further divided into 99 wards (previously parishes). 64% of the city is classified as residential area. Wakiso District surrounds Kampala and Mukono District lies to the east of Kampala. The population of these two districts is 1,997,418 (Wakiso) and 596,804 (Mukono) (UBOS, 2016). In addition to the population living in Kampala, it is estimated that between 750,000 and 1,500,000 people commute daily into the city (KSP, 2008, Kulabako et al., 2010). The total population of Uganda increased by 44% from 24,227,297 in 2002 to 34,856,813 in 2014, of which 6,426,013 live in urban areas (UBOS, 2016). In line with rapid urbanization, approximately 60% of city residents live in informal low-income settlements (“slums”), which cover 10.8% of the city area (Günther et al., 2011). The boundaries of Kampala and its five divisions serve as the basis for the Shit-Flow-Diagram (SFD) assessment (see Figure 3).

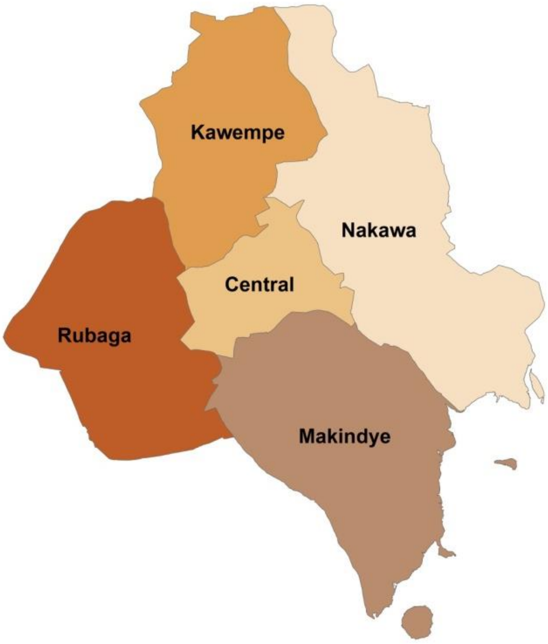

Figure 3: Kampala city boundaries, taken from Bischoff et al. (2016).

Kampala is situated on the northern shores of Lake Victoria, and the lake is the main source of drinking water for Kampala. The city has numerous hills that lie between 1,300 m and 1,350 m, above the mean sea level. It is estimated that 95% of low-income areas and informal settlements lie in valleys. These valleys consist of natural streams or drainage channels and wetlands. Average depth between hill top to valley is about 200 m. The following four wetlands play a key role in Kampala, as effluent from wastewater and faecal sludge treatment either already drains into them, or will in the future. Their locations are shown in Figure 4.

Nakivubo wetland

The Nakivubo wetland is almost completely waterlogged and fed by the Nakivubo channel, which receives the wastewater effluent of the Bugolobi wastewater treatment plant. The less waterlogged areas have been modified by the informal cultivation of yams and sugarcane. Namuwongo, a low income area, expands into the wetland (KSMP, 2004).

Kinawataka wetland

The Kinawataka – Bukasa wetland is the second major wetland after Nakivubo wetland and protects the inner Murchison Bay of Lake Victoria from several catchments, which are heavily industrialized and densely populated. Thereby, this wetland protects Lake Victoria from receiving nutrient rich effluents. The Kinawataka catchment is not connected to the central sewerage system and treatment from industrialized and residential areas does not yet exist (KSMP, 2004).

Lubigi wetland

Fed by the Nsooba river, Nabisisasiro river and others, Lubigi wetland drains into and forms part of the Mayanja Kato lake. The surrounding area has a mix-use of cultivation, settlements and brick-making factories (KSMP, 2004). Since May 2014, the effluent of the Lubigi wastewater and faecal sludge treatment plant drains into the Lubigi wetland.

Nakulongo wetland

The Nakulongo wetland comprises both permanent and seasonal wetland stretching along the Nalukolongo and Mayanja rivers. The wetland is characterized by agricultural activity and settlements and floods excessively during peak rains, affecting many homes and industries

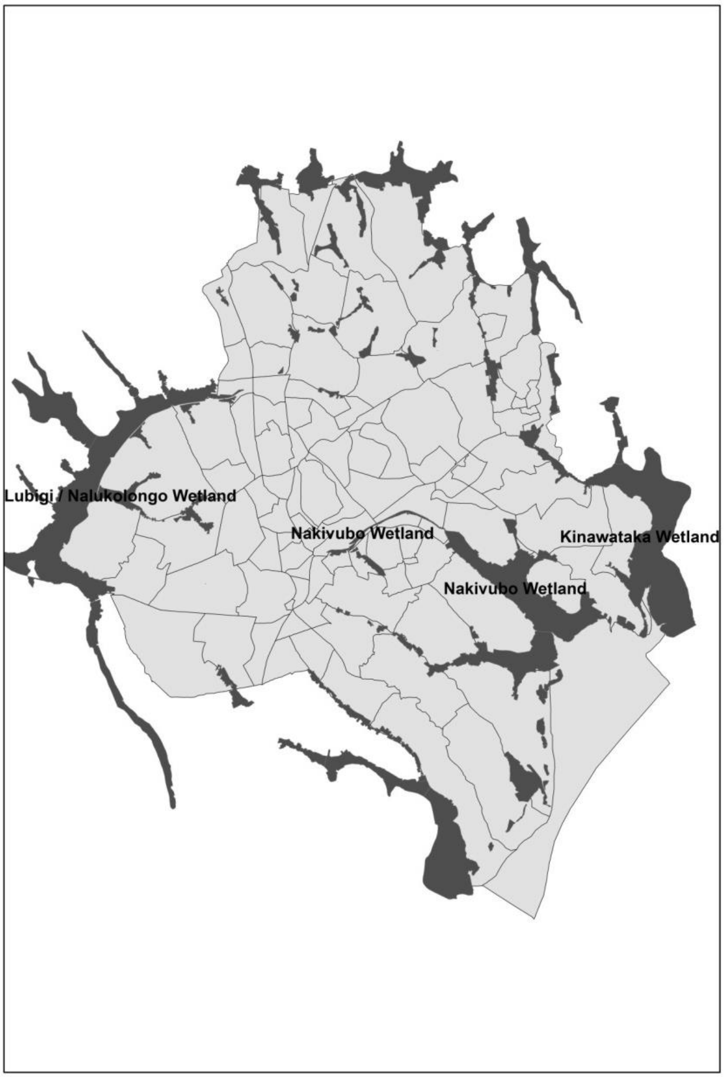

Figure 4: Location of wetlands in Kampala, figure produced by Fabian Bischoff.

2 Service delivery context description

The implementation of water sanitation and hygiene (WASH) activities in Uganda is governed by national policies, laws (Acts) and regulations. In section 2.1, all relevant institutions are described in relation to existing policies, laws and regulations. Figure 5 shows the institutional links between them and Table 1 summarizes the roles and responsibilities of each institution presented in this section. Section 2.2 then presents budget allocated for sanitation service provision and section 2.3 provides an introduction to the National Development Plan, a key document under the Uganda Vision 2040.

2.1 Institutional Roles, Acts, Policies and Regulations

The Constitution of Uganda (1995) provides the basis for the legal framework in Uganda. It lays down national objectives, overall principles of state policy and provides the framework for key policies relevant to WASH. An important document for service provision in Kampala, is the Local Governments Act (1997), which includes a decentralization policy. Local governments include districts, town councils, and sub-counties, which have the mandate and responsibility for planning and implementing water and sanitation sector activities for their communities. On a national level, a district is made up of several counties and municipalities in that area. Counties are made up of sub-counties, where each county is represented in the national parliament in Kampala by an elected member. A sub-county is made up of a number of parishes, which furthermore are made up of villages.

In this context, the city of Kampala consists of 2,959 zones (villages), which are part of 99 parishes. These parishes combined are part of five divisions (sub-counties and counties) and they all belong to one district, Kampala. Kampala is a district and city at the same time, governed by the Kampala Capital City Authority (KCCA). The whole of Kampala district is completely urban and is the only complete urbanized district in Uganda.

Kampala Capital City Authority

Kampala Capital City Authority (KCCA) was established under the KCCA Act (2010) by the Ugandan Parliament as a legal entity that replaced the former Kampala City Council (KCC). The act gives responsibility to KCCA to devolve functions and services to division urban councils. These services include: ‘(l) public health, sanitation, painting of buildings and development of green parks;” and ‘(s) provision of safe water and sanitation in the community;’ (Part B, 29). It furthermore defines the Greater Kampala Metropolitan Area to include Kampala city and the neighboring districts Mpigi, Wakiso and Mukono. The actors for implementation include the Ministry of Lands, Housing and Urban Development, Office of the President, KCCA, and the respective local Governments.

KCCA is partially responsible for sanitation infrastructure. This includes non-sewered access to sanitation. For example, in 2014, KCCA carried out drainage and maintenance works at sanitation facilities installed by KCCA, spending a total of UGX 416 million (113’000 USD) (KCCA, 2015). In addition, with support from WaterAid, the Ugandan non-governmental organization (NGO) Community Integrated Development Initiatives (CIDI), and African Evangelistic Enterprises (AEE), ventilated improved pit (VIP) latrines and two flush type toilets have been constructed in pro-poor schools in Kampala (KCCA, 2015). In addition to access to toilet facilities, KCCA provides some emptying and transportation of faecal sludge in the five divisions of Kampala. One truck is available for each division and mainly serves schools, public toilets and to some extent households in low-income areas (more details are provided in section 3.1.3).

National Water and Sewerage Corporation

This National Water and Sewerage Corporation Statute states that the National Water and Sewerage Corporation (NWSC) shall operate and provide water and sewerage services in areas entrusted under the Water Statute (1995). These areas include the 25 largest towns/cities of Uganda, including Kampala. This document provides clear responsibility of sewer network operation, maintenance and expansion, and wastewater treatment to NWSC. Furthermore, NWSC is the main entity responsible for the implementation of the Kampala Sanitation Master Plan (2004) and the Kampala Sanitation Program (2008), which were developed in cooperation with Mott MacDonald and Fichtner Water and Transportation and supported by the German Development Bank (KfW) as well as the Government of Uganda (KSMP, 2004, KSP, 2008). Within this program the need for adequate provision of faecal sludge treatment infrastructure was realized and resulted in the planning of three wastewater and faecal sludge co-treatment plants, of which one was operationalized in 2014. NWSC is responsible for the operation, maintenance and monitoring of such infrastructure (more details are provided in section 3.1.4).

Private faecal sludge emptying service providers

While the policy, legislative and regulatory frameworks include mandates for the provision of sanitation infrastructure and treatment, there is a gap in the regulatory framework for how faecal sludge should be collected and transported. The need for these services has been recognized by the private sector, and as a result, the total number of privately operated trucks in 2008 was 27, and by 2013 had grown to 45 trucks (KSP, 2008, Schoebitz et al., in preparation) while it is 85 at the present (KII3, 2016). Business owners usually buy vacuum trucks imported from overseas. The crew for each truck normally consists of two employees to drive the truck as well as collect and empty the faecal sludge. There are also around 13 truck drivers in Kampala that own and operate their own trucks. The owner of the truck is responsible for all major costs and services (e.g. tires, vacuum pumps, hosepipes, etc.) (Schoebitz et al., 2014, KII3, 2016).

The Private Emptiers' Association (PEA) was registered in 1999 and is a self-organized trade association for privately owned businesses. Private entrepreneurs that are registered with the PEA receive insurance benefits, access to maintenance of vacuum trucks and, in general, collective representation. In 2015, the Kampala Private Emptiers' Association (KPEA) was formed and so now there are two organizations. The two associations currently operate with a total of 85 trucks (KII3, 2016). NWSC provides space for the trucks to park at both the newly constructed Lubigi wastewater and faecal sludge treatment plant and the Bugolobi wastewater treatment plant (Schoebitz et al., submitted). NWSC maintains low discharge fees for faecal sludge at treatment plants, which is an incentive for legal discharge of faecal sludge and contributes to the fact that illegal discharge by private emptying service provider were not be identified in Kampala. Further information regarding faecal sludge emptying service provision is reported in section 3.1.3.

Ministry of Water and Environment

At the national level, the Ministry of Water and Environment (MWE) is responsible for overall coordination, policy formulation, setting of standards, inspection, monitoring, technical back-up and initiating legislation. The Directorate of Water Development (DWD), Directorate of Environmental Affairs (DEA) and the Directorate of Water Resource Management (DWRM) are part of MWE. In 2001, a Memorandum of Understanding (MoU) was signed between the MWE, the Ministry of Health (MoH) and the Ministry of Education, Science, Technology and Sports (MoESTS), which stipulates mandates for sanitation. The roles and responsibilities of each ministry are presented in Table 1.

The National Environmental Management Authority (NEMA) is directly linked to the MWE and responsible for licensing all private businesses that are dealing with waste. This includes domestic waste, as well as industrial, chemical and construction waste. It is recommended that private entrepreneurs register trucks with NEMA. Relevant regulations, related to NEMA and established under the Constitution of Uganda (1995) as part of the National Environmental Act, Cap 153 (1995) include:

- Environmental Impact Assessment Regulations (1998), which requires an environmental impact assessment prior to the implementation of all projects that are likely to have a significant impact on the environment,
- National Environment Regulations 1999 and 2000, which sets standards for discharge of effluent into water or on land, as well as prohibiting any person from carrying out an activity in a wetland without a permit issued by the Executive Director of the NEMA,
- Water (Waste Discharge) Regulations (I. 32/1998), which regulates the effluent or discharge of wastes on to land or into water. NWSC, for example, implements a performance evaluation of the existing wastewater and faecal sludge treatment plant to check compliance with standards,
- National Environment (Waste Management) Regulations (1999), Regulation 9 (8), which stipulates that at any reasonable time, an environmental inspector can: (a) stop and inspect any vehicle used for transportation of waste; and (b) enter upon any premises where waste is stored.

The National Water Policy (1999) issued by MWE sets the framework for water resources management and development, and the policy documents also include a chapter on domestic water supply that contains references to sanitation. The need to plan for sanitation facilities and drainage of excess water in connection with provision of water supply is recognized. Furthermore, community participation is considered essential when choosing sanitation technologies. Emphasis lies on acceptability (culturally and financially) by user communities with preference on low-cost onsite sanitation technologies.

In 2012, the Joint Water and Environment Sector Support Program (JWESSP, 2013 – 2018) was formulated by the MWE, together with the Water and Environment Sector Development Partners. Two out of eight program components are directly related to sanitation, including the Rural Water Supply and Sanitation Program and the Urban Water Supply and Sanitation Program. Even though not supported by the JWESSP, semi-autonomous agencies such as NWSC, but also NEMA and the National Forestry Authority (NFA) will be involved in sector dialogues, strategy formulation and institutional reforms (MWE, 2012).

Ministry of Health

Another key central government agency with policy and regulatory mandates is the MoH, which is responsible for promotion of public health and sanitation at the household level. Relevant policies include, the National Health Policy (1999), which was prepared within the context of the Constitution of Uganda (1995) and the Local Governments Act (1997). One of the ten guiding principles of the National Health Policy is the collaboration and partnership between public and private sectors, including NGOs, private and traditional practitioners. The policy was revised and updated in 2012.

The Environmental Health Policy (2005) defines environmental health priorities of the Government as well as providing a framework for the development of services together with programs at national and local government levels. It reinforces the Public Health Act (1964, revised in 2000) with the overall policy objective to achieve 100% hygienic sanitation facilities in urban areas. The policy implies that management responsibility and ownership by users of sanitation facilities result in more hygienic facilities. Inadequate access to sanitation and solid waste management, together with poor drainage are recognized as major contributors to the spread of disease. The goal of the Environmental Health Policy is ‘the attainment of a clean and healthy living environment for all citizens’, which is in line with the Health Sector Strategic Plan and the Poverty Alleviation Program. The policy identifies local governments that are responsible for the provision of infrastructure and services essential for public health (e.g. water, public latrines, waste collection and disposal, drainage, sewerage and vector control) while the national government is responsible for establishing policy, legal and institutional frameworks for strategies and services (KSP, 2008).

Furthermore, the MoH provided guidance for the implementation of the National Water Policy (1999), established by the MWE. Guidance is provided by the National Sanitation Guidelines issued by the Ministry of Health in 1992 and revised in 2000 (KSP, 2008). The guidelines were produced in a series of publications developed to support sanitation and hygiene promotion in Uganda. Other publications in this series include:

- Concept Paper: Promotion of Sanitation in Uganda (Ministry of Health, 1997)
- National Sanitation Forum Report (Ministry of Health, 1997)
- National Sanitation Policy (Ministry of Health, 1997)
- Guidelines for School Sanitation (Ministry of Health, 1999)

The MoH is guided by the National Health Sector Reform Program and the National Poverty Alleviation Program (1997, revised in 2001 and 2004) in which water supply and sanitation are recognized as key issues.

Ministry of Education, Science, Technology and Sports

The Ministry of Education, Science, Technology and Sports (MoESTS) is responsible for school latrine construction and public health (hygiene) education in primary schools. It is mandated to provide for, support, guide, coordinate, regulate and promote quality of education and sports to all persons in Uganda (MoES, 2013). The MoES prepared a National Strategy for Girls’ Education (NSGE), which is related to the National Gender Policy (1997) emphasizing the government’s commitment to gender responsive development as part of the Constitution of

Uganda (1995). This strategy includes the formulation of gender responsive policies (NSGE, section 2.1.1), including the construction of separate sanitation facilities for boys and girls and highlighting the aspect that these facilities are critical for girls with disabilities (MoES, 2013).

Relevant policies under development

A Climate Change Policy and a National Urban Policy are currently under development. The National Urban Policy was drafted by the Ministry of Lands, Housing and Urban Development in 2013 and under 'Policy Statement 3: Government shall prepare and implement an effective and sustainable waste (solid and liquid) management system.' it states as one of the strategies to 'Formulate and implement an Urban Sanitation Policy'. However, all other strategies under this policy statement are mainly based on solid waste management and the management of liquid waste, in particular faecal sludge and wastewater are neglected.

The roles and responsibilities assigned to the major institutions, either by legislation, policy or other documents (such as the MoU signed in 2001) are outlined in Table 1. Institutional links between relevant ministries are shown in Figure 5.

Table 1: Roles and responsibilities for sanitation services in Kampala, Uganda (adapted from KSP (2008)).

Function	MoH	MoES	DWRM	DEA	NEMA	NWSC	KCCA
Sewer network O&M						■	
Sewer network expansion						■	
Wastewater/Faecal sludge treatment						■	
Household onsite sanitation	O						■
Public latrines	O					O	■
School latrines	O	■					■
Faecal sludge collection						O	■
Health/hygiene promotion	O	O				O	■
Surface water drainage							■
Solid waste collection/disposal							■
Water quality monitoring			■		■	O	O
Wetlands management				■			O
Waste/discharge permitting			■		■	O	O
Investment planning						■	■
Physical planning							■
Planning control			O				■
■= major role O= minor role							

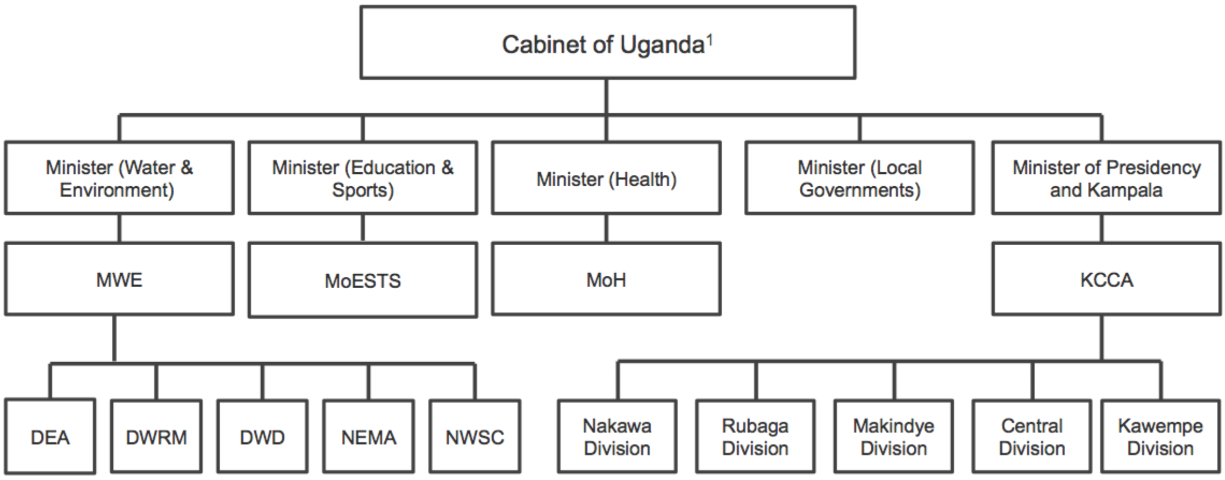

Figure 5: Institutional links in Kampala, Uganda (adapted from KSP (2008)). In addition, there are multiple interlinkages that are not depicted (e.g. KCCA is the implementing agency for MoH).[1]

2.2 Budget allocation

Based on the Ministerial Policy Statement (KCCA 2015), the total budget allocated for protection of public health, sanitation services and solid waste management for the financial year 2014/15 in Kampala was UGX 18.85bn (USD 5.15 million) of which around 30% was allocated for payment of salaries and allowances for health workers and casual laborers. Roughly another 30% was for the expansion and maintenance of the Kiteezi landfill, which is the disposal site for municipal solid waste. Only 3% was allocated for upgrading public health infrastructure and improving community sanitation and water supplies. The same amount was allocated for renovation, maintenance and running cost of public toilets owned and operated by KCCA (KCCA, 2015).

2.3 National Development Plan 2015/16 – 2019/2020

Recently, the National Planning Authority (NPA) published the second version of National Development Plan (NDP II) 2015/16 – 2019/2020 under the Uganda Vision 2040. The NDP II,, which guides all planning activities in the country, is an overarching framework. A section of it addresses the fragmented structure of sanitation service provisions and furthermore addresses the lack of faecal sludge management. This is an important advancement for future provision of sanitation in Uganda, and formalizing the FSM sector is high on KCCA agenda for the coming year. The sections of the NDP II specifically related to the provision of urban sanitation and hygiene services include:

Objective 4: Improve urban sanitation and hygiene services.

i. Intensify collaboration among MWE, MoH and Local Governments,

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[1] According to Section 111 of the Constitution of Uganda (1995), the Cabinet of Uganda shall consist of the President, the Vice President, the Prime Minister and such number of Ministers as may appear to the President to be reasonably necessary for the efficient running of the State

ii. Increase sewerage connections in towns with sewerage systems and develop new infrastructure, including satellite sewerage systems in the Greater Kampala Metropolitan Area,
iii. Develop Smart Incentive Schemes and intensify Sanitation Marketing for increased household investments in sanitation,
iv. Construct, operate and maintain a cluster of Faecal Sludge Management Treatment Systems while promoting private sector services for sludge collection and disposal,
v. Strengthen law enforcement bodies with regards to Sanitation and Hygiene.

Faecal sludge treatment is included as a specific term for the first time, and it also includes the promotion of the private sector for faecal sludge collection and disposal. The NDP II furthermore includes objectives and strategic interventions specifically for the Greater Kampala Metropolitan Areas. The four key objectives are:

1. Improve the institutional and legal framework governing the Greater Kampala Metropolitan Area.
2. Improve Physical Infrastructure of the Greater Kampala Metropolitan Area.
3. Improve the livelihoods of urban dwellers in the Greater Kampala Metropolitan Area.
4. Improve environmental and ecological planning of the Greater Kampala Metropolitan Area.

Objective 3 of the NDP II includes the intervention to “Promote regulated urban agriculture” Objective 4 includes the intervention to “Promote public safety and hygiene through mindset change” and other interventions related to waste management activities.

Objective 9 is to some extent related to sanitation services, but particularly important for KCCA as it includes the interventions of upgrading and revitalizing declining areas within Kampala City; the development of detailed city neighborhood physical plans; and upgrade of Kampala “slums”.

3 Service Outcomes

3.1 Overview

3.1.1 Sanitation technologies

In Kampala 92.5% of residents are served by onsite sanitation technologies, which are either pit latrines or septic tanks. 7.5% of the population use flush toilets connected to piped sewers, which is more common in high-income and industrial, institutional and commercial areas (e.g. Central Division).

In addition to sewers, septic tanks are the primary technology used in medium- and high-income areas, while pit latrines can be found more commonly in low-income and “slum” areas (informal settlements). Income categories were defined as part of the Kampala Sanitation Master Plan (2004), and based on:

- 1991 and 2002 census data provided by the Uganda Bureau of Statistics (UBOS),
- Results of a household survey (n ~ 5,000).

These estimated categories of income were then connected to land use forecasts and population density, used by the Kampala Sanitation Program (2008) (KSMP, 2004, KSP, 2008). Different types of pit latrines can be found in Kampala, such as VIP latrines, raised pit latrines, and conventional pit latrines (KSP, 2008). It is estimated that 60% of Kampala’s residents live in low-income areas and informal settlements, of which 95% are located in valleys with high groundwater table (Günther et al., 2011, KII1, 2015). The percentage population using sanitation facilities shared by multiple households in low-income areas and informal settlements is 68% (Tumwebaze and Luethi, 2013). Only 20% have private sanitation facilities, used by one household only as defined by the Joint Monitoring Programme (JMP, 2015). Public toilets, also referred to as pay-per-use toilets or community toilets, are used by 11%, while it is estimated that 1% of the population in low-income areas and informal settlements practices open defecation (Tumwebaze and Luethi, 2013). In these areas, it is estimated that around 77% of the latrine technologies are raised pits, which are fully lined (Nakagiri et al., 2015). In this context, fully lined is analogous to a fully-lined raised tank without an overflow or infiltration into the ground. However, full confirmation on whether or not these tanks are “sealed” is not possible (KII1, 2015).

3.1.2 Excreta from different origin categories

Kampala is the central commercial and industrial hub in Uganda, and during the day many people commute into the city for work with a result that the estimated daily population doubles (KSP, 2008). This significantly impacts the amount of excreta that is generated within the Kampala boundaries on a daily basis. However, there is no available information on toilet usage by the commuting population. If estimated that 50% of toilet usage is while in Kampala, then it increases population equivalents producing excreta by 750,000.

The estimated total volume of wastewater (connected to sewers) for 2013 was 65,000 m^3/d, with 60% from domestic sources and 40% from institutional, commercial and industrial sources (KSP 2008). This percentage, however, does not include the commuting fraction. For this SFD, it was estimated that 50% of the commuting population uses public toilets and 50% use toilets that are connected to piped sewers.

3.1.3 Faecal sludge emptying service providers

Private mechanical emptying service providers use vacuum trucks for emptying, collection and transport of faecal sludge (see Figure 6). In total, 85 of these trucks are currently operating and belong either to the KPEA or the PEA (Schoebitz et al., submitted, KII3, 2016). Between 2008 and 2016, the number of trucks in operation has more than doubled. This growth illustrates the response of the market to the demand for faecal sludge emptying services. Estimated costs per emptying trip are reported to be 80,000 UGX (24 USD) for 2 m^3 and 150,000 UGX (45 USD) for 10 m^3, which is 4.5 to 12 USD per 1 m^3 emptied faecal sludge (Murungi and van Dijk, 2014).

Figure 6: Mechanical faecal sludge emptying service provision. Top left: Members of the PEA. Top right: Vacuum truck. Bottom left: Emptying of septic tank. Bottom right: Emptying of pit latrine (Schoebitz, 2016).

KCCA also owns twelve vacuum trucks. Six are used for surveillance/maintenance of the sewerage network, however, five of them are currently not in operation. The other six trucks are used for faecal sludge collection and transport for hospitals, markets, schools, community and shared toilet facilities (operated by KCCA), private households and the commercial sector, in that order of importance. One truck provides collection and transport services to a public latrine at Nakawa Market about four times a day. Customers, who are not in the category of public sector have to pay for services, with KCCA charging 65’000 UGX/trip (19 USD/trip) for the commercial sector or households. KCCA owns and operates public toilets in low-income areas and informal settlements. Operational costs for faecal sludge emptying are covered by monthly community fees or by revenues generated from “pay per use” toilets. KCCA also operates 14 public toilets, located at Nakawa Market (2), Centenary Park (1), Entebbe Road (1), Constitution square (2), Bombo Road (2), New Taxi Park (2), Usafi Market (2) and Wandegeya Market (2) (KII2, 2016, KII3, 2016).

However, in areas with high population density and narrow roads, vacuum trucks cannot access containment technologies. Additionally, the costs for emptying may be a burden for low-income households, who often cannot afford these services. This gap is filled by manual emptying service providers. Two types of manual emptying service provider exist; (1) service provision with semi-mechanized equipment, such as the gulper, and (2) informal service provision.

In 2014, there were around 15 private entrepreneurs using the gulper for collection and transport, supported by Water for People. Faecal sludge is collected in 200L barrels and then transferred by pick-up trucks to the Lubigi wastewater and faecal sludge treatment plant. Between December 2012 and July 2014, 649 containment technologies were emptied, which were used by a total of 9,091 people. The average volume of faecal sludge removed per containment was 1.02 ± 0.68 m^3 (n = 649). The costs for emptying per barrel of emptied sludge was 30’000 UGX (9 USD), and the average cost was 45 USD for 1 m^3 (WfP, 2015).

The number of informal manual emptying service providers is not known. Faecal sludge emptied by the informal sector is typically directly dumped in the nearby neighbourhood, either into a hole they dig, or into storm water channels (Tsinda et al., 2015). The costs for emptying depend on a variety of factors. Presence of solid waste in the containment increases the costs of emptying. Depending on the specific situation, the costs of emptying range from 30,000 UGX (9 USD) to 100,000 UGX (30 USD) (Murungi and van Dijk, 2014). The volume emptied from containment is unknown.

Another way pit latrines located next to storm water channels are emptied, is that during the a flooding even in the rainy seasons, a hole is made at the raised part of the containment structure so that the sludge drains directly out into the flood water. This can either be done individually, or for relatively low fees (e.g. 9 USD) (Murungi and van Dijk, 2014).

Summarized in Table 2 are the costs for emptying services in Kampala. It is apparent that manual emptying services are more expensive than mechanical. The demand for manual service provision arises due to the inaccessibility of containment technologies, or that they are unlined pits, meaning that trucks will not empty these containment technologies for fear of collapse. Based on the cost for 1 m^3 of emptied faecal sludge, low-income households can pay up to ten times more for emptying services compared to households that can make use of mechanical emptying service providers. The costs could potentially be brought down at the household level if more options were made available for entrepreneurs with gulpers to reduce transport costs, for example, by the use of transfer stations.

Table 2: Costs for emptying services in Kampala, Uganda.

Type of service	Mechanical service provision		Manual service provision	
Service Provider	KCCA	KPEA + PEA	Gulper entrepreneurs	Informal sector
Costs for emptying service per trip [USD]	19	24 to 45	45	9 to 30
Costs for emptying [USD/m^3]	4	4.5 to 12	45	unknown

3.1.4 Treatment infrastructure

There are currently four wastewater treatment plants in operation in Kampala. Three of them are designed for wastewater only, and one is a faecal sludge and wastewater treatment plant in parallel (see Table 3). The Bugolobi wastewater treatment plant was constructed between 1968 and 1974 and refurbished during 1986 to 1987, this treatment plant has a total capacity of 33,000 m^3/d. Until 2014, an official faecal sludge discharge location was provided at this treatment plant. Faecal sludge was discharged into settling tanks, and the liquid effluent was directed to the influent of the treatment plant. These settling tanks were removed and faecal sludge is now discharged directly at the influent to the wastewater treatment, as the only existing wastewater and faecal sludge treatment plant already operates at maximum capacity for faecal sludge discharge. Details on treatment performance are provided in section 3.2.3.

In 2014, the first treatment plant designed specifically for wastewater and faecal sludge treatment in Kampala was commissioned. Presented in Figure 7 are photos of the treatment plant and in Figure 8 the process flow. This plant has a design capacity of 5,000 m^3 wastewater per day and 400 m^3 faecal sludge per day. As described above, this treatment plant reached operating full capacity for faecal sludge treatment within three months of operation. Faecal sludge undergoes solids-liquid separation in settling/thickening tanks. The solid fraction is then transferred to covered unplanted drying beds for dewatering, while the liquid effluent is co-treated in waste stabilization ponds with effluent from primary wastewater treatment. Additionally, uncovered unplanted drying beds are located at the treatment plant for dewatering of wastewater sludge. The effluent of the ponds is then discharged in the Lubigi wetland (Schoebitz et al., 2014).

Additionally, three decentralized wastewater treatment plants are located in Naalya and Ntinda, and Bugolobi flats, with a combined treatment capacity of 1,200 m^3 wastewater/d in waste stabilization ponds (Schoebitz et al., 2014).

Currently, the Bugolobi wastewater treatment plant is being upgraded, and will have a future capacity of 45,000 m^3/d. Once it is commissioned it will also receive influent from Kinawataka and Butabika Hospitals (Seminar, 2016).

Two additional treatment plants were planned under the Kampala Sanitation Program (2008), with a similar process flow to the Lubigi treatment plant. Nalukolongo will go ahead but is not yet in construction phase, and the future of Kinawataka treatment plant is not clear.

Figure 7: Lubigi wastewater and faecal sludge treatment plant. Top left: Discharge. Top right: Settling/thickening tanks. Bottom left: Drying beds. Bottom right: Dewatered faecal sludge. Photos (Schoebitz, 2016)

Table 3: Design capacity of operational faecal sludge and wastewater treatment plants in Kampala.

Location	Design capacity in m^3/d	Technology
Bugolobi	33,000	**Wastewater treatment** Settling tanks, anaerobic digestion, trickling filter, drying beds
Naalya	750	**Wastewater treatment** Waste stabilization ponds
Ntinda	320	**Wastewater treatment** Waste stabilization ponds
Bugolobi flats	105	**Wastewater treatment** Waste stabilization ponds
Lubigi	5,000	**Wastewater treatment** Waste stabilization ponds, uncovered drying beds
	400	**Faecal sludge treatment** Settling/thickening Tanks, covered drying beds, leachate co-treatment in waste Stabilization pond

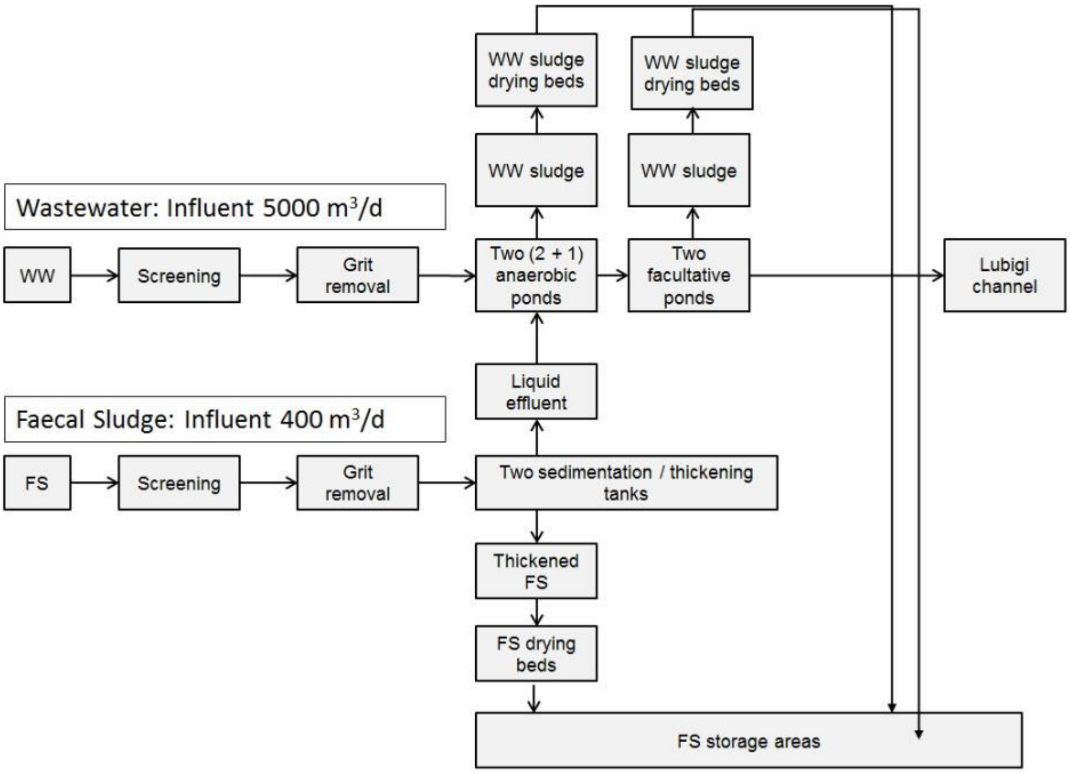


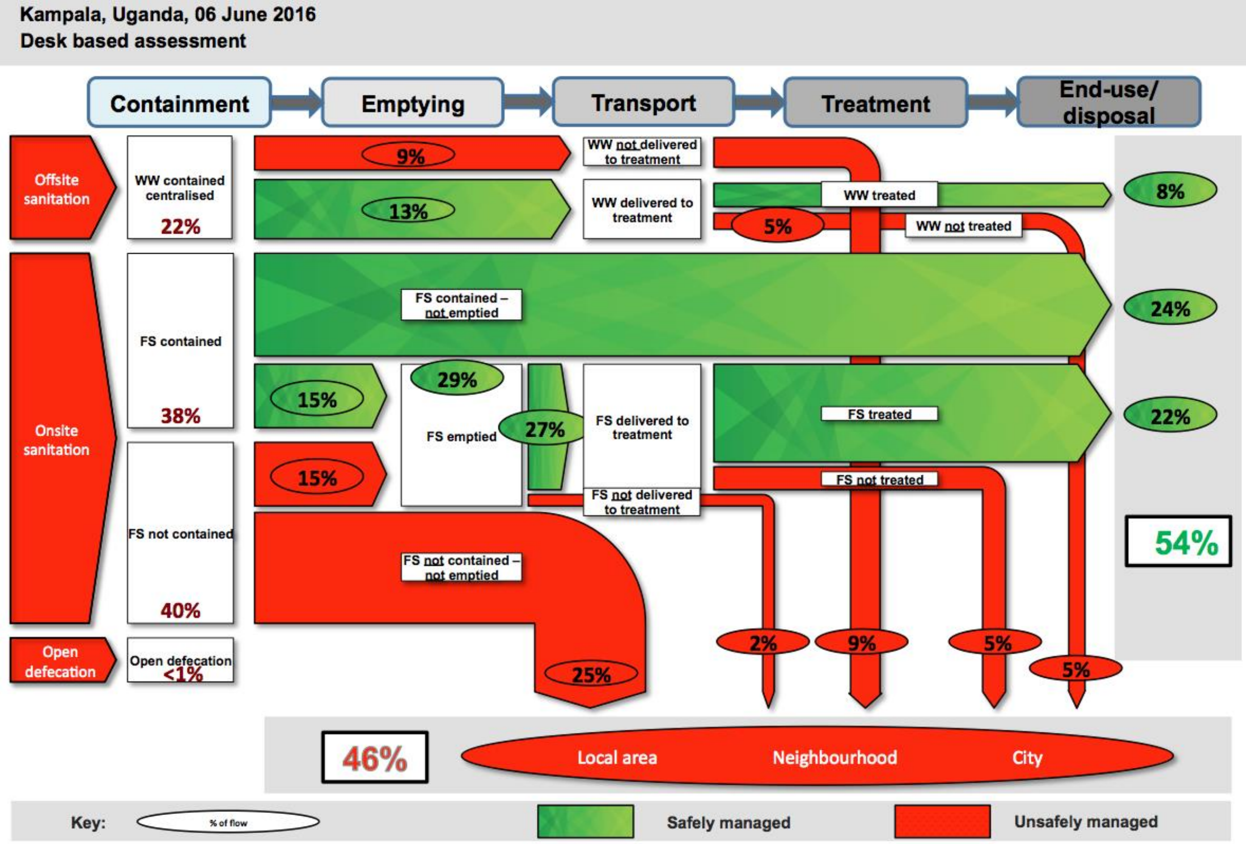
Figure 8: Process flow of the Lubigi wastewater and faecal sludge treatment plant (Schoebitz et al., 2014).

3.1.5 End-use / Disposal

Dewatered faecal sludge and wastewater sludge is dried and stored at the Lubigi and Bugolobi treatment plants, after which, it is sold to farmers. However, attempts are being made to promote the use of sludge for resource recovery including public private partnership agreements through NWSC to provide private entrepreneurs with dewatered faecal sludge. Private entrepreneurs (e.g. Strong Youth for Development International) hope to use dewatered faecal sludge to produce briquettes, which could then be used as a fuel in industries. Several approaches and technologies are being tested. Research activities are being conducted to support the development of these technologies (Gold et al., 2014, Muspratt et al., 2014, Gold et al., submitted).

3.2 SFD Matrix

Presented here is the resulting SFD based on the above data collection. A detailed explanation of all assumptions to derive percentages of excreta fate are described in detail below in sections 3.2.1 to 3.2.3.



Note: Percentages do not add up to 100 due to rounding

3.2.1 Groundwater pollution risk

The parameters influencing the risk of groundwater pollution were assessed for low-income areas and informal settlements, and for medium- and high-income areas. Provided in Table 4 is an overview of the decisions that were made for each question to enter data into the calculation tool. For low-income areas and informal settlements the risk for groundwater pollution is significant. As mentioned before, low-income households are often located in valleys, where the groundwater table is high, sanitation facilities are located closely to drinking water sources, and the percentage of drinking water produced from groundwater sources is high (contaminated, shallow groundwater). For medium- and high-income areas there is a low risk for groundwater pollution, which is the result of a depth to the groundwater table of more than 10 m and sanitation facilities being located further than 10 m from groundwater sources. Additionally, medium- and high-income areas mainly use treated surface water from Lake Victoria as the source of drinking water (KII1, 2015). This assessment was based on experience of the authors and confirmed by local experts. The SFD presents the fate of excreta on a city-wide scale, so for each type of onsite containment, the groundwater risk is evaluated differently for both income scenarios.

Table 4: Summary of SFD calculation tool for groundwater pollution risk in Kampala (KII1, 2015).

Questions	**Low-income areas and informal settlements**	**High- and medium-income areas**	**Kampala**
1 (A) What is the rock type in the unsaturated zone?	fine sand, silt, clay	fine sand, silt, clay	fine sand, silt, clay
1 (B) What is the depth to the groundwater table?	< 5 m	> 10 m	Both of scenario 4 and 5
Question 1: Outcome	**Significant**	**Low**	**Significant and low**
2 (A) What is the percentage of sanitation facilities that are located <10m from groundwater sources?	Greater than 25 %	Less than 25%	Both of scenario 4 and 5
2 (B) What is the percentage of sanitation facilities, if any, that are located uphill of groundwater sources?	Greater than 25%	Less than 25%	Both of scenario 4 and 5
Question 2: Outcome	**Significant**	**Low**	**Significant and low**
3 (A) Percentage of drinking water produced from groundwater sources	Greater than 25%	Between 1% and 25%	Both of scenario 4 and 5
4 Water production technology	Protected boreholes, protected dug wells or protected spring where adequate sanitary measures are in place	Protected boreholes, protected dug wells or protected spring where adequate sanitary measures are in place	Protected boreholes, protected dug wells or protected spring where adequate sanitary measures are in place
Groundwater pollution risk level	**Significant**	**Low**	**Significant and low**

3.2.2 Offsite sanitation

1. Piped sewer connection

Of the total Kampala population, 7.5% are connected to piped sewers (KSP, 2008). To simplify the diagram, all sewers were considered as centralized treatment.

2. Transport

The estimated volume of generated wastewater for 2013 was 65,000 m^3/d, with 60% from domestic sources and 40% from institutional, commercial and industrial sources (KSP 2008).

Currently, five wastewater treatment plants are operating in Kampala with a total capacity of 39,175 m^3/d (see Table 3), which is 60% of previously forecasted values.

The Kampala Sanitation Master Plan identified several issues causing blockages of the sewer lines, siphons and pumping stations (KSMP, 2004). Therefore, it was assumed that 40% of the generated wastewater is not actually delivered to treatment. This percentage also includes wastewater from institutional, industrial and commercial areas.

3. Treatment

As summarized in Table 5, the percentage of wastewater that is treated was assumed to be 58%. Further explanation is provided below.

Lubigi

Wastewater treatment performance at Lubigi was assumed to be 100% based on internal reports of NWSC providing evidence that effluent complies with discharge limits for suspended solids, organic material and nutrients, while insufficient information exists on pathogen inactivation (NWSC, 2016).

Bugolobi

Wastewater treatment performance at Bugolobi was assumed to be 50% based on current operating conditions and internal reports of NWSC indicating that effluent did not meet discharge limits for nutrients, organics and solids. Insufficient information exists about pathogen removal (reference 2012 and 2013) (Schoebitz et al., 2014). Faecal sludge is currently being discharged at the influent of Bugolobi treatment plant. This treatment plant was not designed for faecal sludge, and so is overloaded with solids, organics and nutrients, and is not functioning as designed. However, the treatment plant is currently being refurbished, and in the future is expected to operate as designed

As the effluent of Bugolobi directly drains into the Nakivubo channel, next to which many low-income and informal settlements are located, the contamination has a direct impact on public health, in addition to environmental pollution. A health risk assessment by Fuhrimann et al. (2015) has shown a high prevalence of intestinal parasitic infections in farmers (76%), exposed community member (53%), non-exposed community members (45%), wastewater, treatment plant workers (42%), and mechanical emptying service provider (36%). The mean concentrations of thermo-tolerant coliforms in the Nakivubo channel and wetlands were above national standards. Moreover, mean *E. coli* concentrations where above the thresholds suggested by the World Health Organization (WHO) guidelines for the safe use of wastewater in agriculture (WHO, 2006).

Naalya/Ntinda/Bugolobi flats

No records could be obtained for treatment performance of the waste stabilizations ponds in Naalya, Ntinda and Bugolobi flats. Based on observations in 2013, the ponds were considered to be functioning as designed (see Figure 10 and Figure 11). Therefore, the percentage of wastewater treated was assumed to be 100%.

Table 5: Wastewater treatment in Kampala.

Treatment plant	Wastewater influent	Wastewater treated
Lubigi	5,000 m^3/d	100%
Bugolobi	33,000 m^3/d	50%
Bugolobi flats	105 m^3/d	100%
Naalya	750 m^3/d	100%
Ntinda	320 m^3/d	100%
Total	**39,175 m^3/d**	**58%**

3.2.3 Onsite sanitation

1. Containment

Step 1

To assess the percentage of the population using different containment technologies, the Kampala population was assumed to be 1,500,000 and the commuting population 750,000 (KSP, 2008). It was then assumed that 60% live in low-income areas and informal settlements, and 40% in medium- and high-income areas, not including the commuting population (Günther et al., 2011).

Step 2

Of the 60% of the population that lives in low-income areas and informal settlements, 68% use sanitation facilities, shared by a defined number of multiple households, 20% use private sanitation facilities as defined by JMP (2015), 11% public toilets, and 1% open defecation (Tumwebaze and Luethi, 2013). Of the 40% of the population in medium- and high-income areas, it was assumed that all sanitation facilities are private facilities in use for one household only as defined by JMP (2015) (KII1, 2015).

Step 3

To calculate percentages of the population using different containment technologies, the information provided in KSP (2008) was used as a starting place. The specific details for each of the categories are presented in Appendix 7.3, **Error! Reference source not found.**. The percentage population using each type of containment technology is presented in Table 6.

Table 6: Average of use of containment technology in different income areas of Kampala.

	Average (based on Table A3)	
Containment technology	**High/medium-income area**	**Low-income area/informal settlements**
Septic tank	52%	13%
VIP latrine	27%	28%
Pit latrine	20%	48%
Pit latrine raised	2%	8%
Public toilet	0%	3%
Other	0%	3%

Step 4

The total percentage of population in medium- and high-income areas using different containment technologies or are connected to the sewer is presented in Table 7. These values are based on the following assumptions: as presented in section 3.2.2, 7.5% of Kampala's population is connected to the sewer; only population in medium- and high-income areas is connected to the sewer; and population in low-income areas and informal settlements solely uses onsite sanitation technologies. This results in an estimate of 19% of 600,000 inhabitants living in- and high-income areas being connected to the sewer (KSP, 2008, Günther et al., 2011). It was also assumed that there are no raised pit latrines in medium- and high-income areas.

Table 7: Percentages of population using different sanitation technologies in high- and medium-income areas.

Sanitation technology	High/medium-income area
Sewer	19%
Septic tank	43%
VIP latrine	23%
Pit latrine	16%
Pit latrine raised	0%
Public toilet	0%
Other (i.e. open defecation)	0%

Step 5

The values in Table 6 were adjusted to account for the difference between shared, private and public sanitation facilities, as shown in Table 8.

Private sanitation refers to sanitation facilities used by single households as defined by JMP (2015). Shared sanitation refers to sanitation facilities that are used by a defined number of multiple households, which means that always the same number of household use the facility. Both, shared and private sanitation facilities are built and owned by either the household or the landlord. Public toilets, however, are built by the municipality in collaboration with NGOs and are also referred to as pay-per-use or community toilets.

Based on income data, it was assumed that private sanitation facilities have a higher percentage of septic tanks, and shared sanitation facilities are a type of latrine. Public toilets were split evenly between septic tanks and latrine technologies.

Table 8: Sanitation technologies in use at shared and private sanitation facilities, and public toilets in low-income areas and informal settlements.

Sanitation technology	Shared sanitation facilities	Private sanitation facilities	Public toilets
Sewer	0%	0%	0%
Septic tank	10%	20%	50%
VIP latrine	30%	28%	50%
Pit latrine	50%	45%	
Pit latrine raised	10%	7%	

Step 6

Next, an expert interview was conducted to transfer the definitions used in Kampala into the SFD method terminology, in addition to fine tuning percentages presented in the previous tables. The result was that the latrines in Kampala are 20% fully lined, 20% semi-lined and 40% unlined (KII1, 2015).

However, raised pit latrines are assumed to always be at least semi-lined, as they are built above the ground in areas with high groundwater table. Therefore the percentage for raised pit latrines was split to 1/3 fully lined and 2/3 semi-lined pits. Additionally, VIP latrines were assumed to always be at least semi-lined and the percentage was therefore split to 1/5 fully lined and 4/5 semi-lined pits.

It was also difficult to fully confirm for fully lined pit latrines whether or not the pit is sealed or if it actually still infiltrates into the ground. To not overstate the amount of excreta that is safely managed, fully lined pits were defined as “Lined tank with impermeable walls and open bottom” rather than “Fully lined tank (sealed), no outlet or overflow”.

Based on the expert interview and after including the additional assumptions described above, the final numbers are: 22% fully lined, 62% semi-lined, 16% unlined.

By definition of the SFD method terminology, a correctly designed septic tank has two chambers and the effluent discharges into a soak pit. Septic tanks with one chamber, however, are classified as fully lined tanks (sealed), discharging effluent to a soak pit. Based on an expert interview the proportion of septic tanks with two chambers is 25%, and 75% have one chamber and are therefore categorized as fully lined tanks.

Step 7

As described in step 1, the commuting population was estimated to be 750,000 people. Without any source of detailed information available, it was assumed that 50% of the commuting population use toilets connected to piped sewers, while the other half uses public toilets, of which 50% were assumed to be connected to septic tanks and 50% to latrines, split into 1/3 fully lined pits and 2/3 semi-lined pits.

Step 8

Summarized in Table 9 are terminology used for onsite sanitation technologies in Kampala together with how they translate to SFD terminology. As presented in Table 12, the final step in this calculation was to convert values for the Kampala population of 1,500,000 and the commuting population of 750,000 to percentages. These percentages provide the basis for the next calculations on emptying, transport and treatment.

Table 9: Kampala and SFD terminology

Final term	SFD terminology
Sewer	No onsite container, user interface discharges directly to centralised foul/separate sewer
Septic tank (two chamber)	Septic tank to soakpit
Septic tank (one chamber)	Fully lined tank (sealed) to soakpit
Fully lined pit latrine	Lined tank with impermeable walls and open bottom, no outlet or overflow
Semi-lined pit latrine	Lined pit with semi-permeable walls and open bottom, no outlet or overflow
Unlined pit latrine	Unlined pit, no outlet or overflow
Open defecation	Open defecation

Table 10: SFD Percentages of population using different types of sanitation technologies in Kampala.

Sanitation technology	Containment outcome	Population	Percentage of total population
No onsite container, user interface discharges directly to centralised foul/separate sewer	Contained	487'500	21.7%
Septic tank to soakpit	Contained	251'250	11.2%
Septic tank to soakpit	Not contained	73'800	3.3%
Fully lined tank (sealed) to soakpit	Contained	191'250	8.5%
Fully lined tank (sealed) to soakpit	Not contained	72'900	3.2%
Lined tank with impermeable walls and open bottom, no outlet or overflow	Contained	109'000	4.8%
Lined tank with impermeable walls and open bottom, no outlet or overflow	Not contained	165'300	7.3%
Lined pit with semi-permeable walls and open bottom, no outlet or overflow	Contained	311'000	13.8%
Lined pit with semi-permeable walls and open bottom, no outlet or overflow	Not contained	424'200	18.9%
Unlined pit, no outlet or overflow	Not contained	154'800	6.9%
Open defecation	Not contained	9'000	0.4%
Total sum	**-**	**2,250,000**	**100%**

2. Emptying estimate

To estimate the percentage of the population who have onsite sanitation where faecal sludge from containment technologies is emptied, three data sources were used:

1. Schoebitz et al. (in preparation)

When onsite containment is emptied, it was estimated that 40% of the faecal sludge is removed. This percentage is applied for percentage of population using septic tanks, VIP latrines and raised pit latrines with emptying. These results are based on interviews (n = 180) with collection services at the household level, using lined or semi-lined pit latrines. Comparing the volume of containment with the volume of the truck that emptied the containment, on average 60% of the faecal sludge remains inside the containment after emptying (assuming it is 100% full at time of emptying).

2. Water for People, Kampala (2015)

To estimate percentage of unlined pit latrines that are emptied, this data based on entrepreneurs with Gulpers was used.

> *Based on the average quantity of faecal sludge removed from containment 1.02 ± 0.68 m^3 (n = 612), the average number of people for all emptied containment technologies 15 ± 56 capita(n = 612, median = 7) and the total number of days (n = 608) between December 2012 and July 2014, the average amount is 0.20 L/cap*day.*

3. Günther et al. (2011)

The remaining 45% of onsite technologies are either abandoned, or are not emptied but still in use (see Figure 9). Data was obtained from 1,500 households living in low-income areas informal settlements.

Figure 9: Damaged and abandoned pit latrine (Schoebitz, 2016).

The next step was to calculate the total volume of faecal sludge that is emptied or not emptied. 31% was derived for the population using unlined pits with emptying by dividing the proportion of emptied faecal sludge by the calculated total.

3. Transport

To estimate the amount of faecal sludge that is collected and delivered to treatment (versus dumped in the environment) 100% collected was used for medium- and high-income areas (on hills), where it is assumed mechanical emptying service provision takes place. In these areas, all sludge is emptied, collected and transported with vacuum trucks, and delivered to treatment. 100% was also assumed for septic tanks in low-income areas and informal settlements, based on the assumption that informal manual emptiers only empty pit latrines in these areas (Murungi and van Dijk, 2014, KII1, 2015).

The percentage of faecal sludge delivered to treatment was estimated at 80% for low-income areas and informal settlements by mechanical or manual emptying service providers using the Gulper. It was furthermore assumed that 100% of faecal sludge emptied by these two methods is collected, transported and delivered to treatment. We assume that 20% of the population using containment with emptying in these areas, are either receiving services by informal manual emptying service provider or empty the containment themselves. Based on information outlined in section 3.1.3, it can be expected that the emptied sludge is not delivered to treatment.

The total quantity of emptied, but not collected, transported and delivered faecal sludge was estimated at 88 m^3/d (KII1, 2015).

4. Treatment

Of the faecal sludge that is delivered to treatment plants, it was estimated that 83% is treated. This estimate was based on:

- Daily records of faecal sludge quantities discharged at Lubigi (220 days) (NWSC, 2014)
- Daily records of faecal sludge quantities discharged at Bugolobi (94 days) (NWSC, 2015)
- Treatment performance report of Lubigi treatment plant in April 2016 (NWSC, 2016)
- Design specifications of Bugolobi treatment plant (KSP, 2008)

While generally reported in key informant interviews that daily quantities of faecal sludge discharged at Lubigi correspond to the actual design capacity of 400 m^3/d, this number was furthermore confirmed by calculating the average daily volume of faecal sludge discharged at Lubigi treatment plant between the start of operation in May 2014 and December 2014 was 385 ± 142 m^3 (median = 366). Between November 2014 and February 2015, on average 103 m^3 faecal sludge per day were discharged at Bugolobi (NWSC, 2014, NWSC, 2015). In total, this results in 488 m^3 faecal sludge per day, discharged at both treatment plants together. Schoebitz at al. (in preparation-b) reported an average daily quantity of 626 m^3 in 2013. To account for this difference, the daily quantity of faecal sludge discharged at Bugolobi was set to 200 m^3 and at Lubigi to 400 m^3, which was furthermore confirmed to be a realistic estimation (KII1, 2015).

In Table 11, the final calculations for treated faecal sludge are presented. As the effluent of Lubigi treatment plant complies with discharge limits, treated faecal sludge was considered to be 100%. The Bugolobi treatment plant is not designed for faecal sludge, but to acknowledge that faecal sludge is delivered to an official discharge location and not dumped into the environment, the percentage was set to 50%. The sum of faecal sludge discharged, in proportion to faecal sludge treated, then results in 83% faecal sludge treated.

Table 11: Percentage of faecal sludge treated in Kampala.

Treatment plant	Faecal sludge discharge	Faecal sludge treated
Lubigi	400 m^3/d	100%
Bugolobi	200 m^3/d	50%
Total	**600 m^3/d**	**83%**

Figure 10: Waste stabilization ponds in Naalya, Kampala. Photos: Lars Schoebitz, November 2013.

Figure 11: Waste stabilization ponds in Ntinda, Kampala. Photos: Lars Schoebitz, November 2013.

3.3 Quality of data

The quality of available data was generally ranked high. The KSMP (2004) and the KSP (2008) provided an excellent source of background information for the service delivery context description as well as the service outcomes. An extensive household survey was implemented in 2004, which in addition to the housing census of 1992 and 2002, produced reliable estimations of projected types of onsite containment technologies in use at the household in 2013.

In total, seven peer reviewed journal articles served as a source of data. These articles were published between 2010 and 2015, including information along the entire sanitation service chain. Household surveys in these publications ranged from a total number of interviews between 100 and 1,500. In addition, data in three manuscripts that are in preparation or already submitted by Eawag/Sandec were used.

Key informant interviews were used to fill in missing information on technical details of containment construction, as reliable data on those details was not available. In the future, the confidence of estimated risk to groundwater pollution could be improved with more accurate data. As the 2014 housing census results become available, the demographic data should be reviewed for accuracy.

4 Stakeholder Engagement

Eawag/Sandec has been collaboratively conducting research in Kampala for seven years together with Makerere University, NWSC, KCCA, Water for People, and private faecal sludge emptying service provider. This existing research experience, together with literature review, was used as a basis for the first draft of this report. The report has undergone a first round of comments by collaborators.

Appendix 1 and Appendix 2 provide an overview of stakeholders that were identified for key informant interviews, as well as date and purpose of engagement. Interviews were conducted by telephone and email. In addition, the experience of Eawag/Sandec was incorporated in the report.

The confidence of this estimation based on desk-based data collection could be increased through further in-field verification. This well be done at the Kampala WASH Symposium in June 2016.

5 Acknowledgements

The authors are very appreciative for the support and cooperation of all participating members of the Private Emptiers' Association (PEA) and Kampala Private Emptiers' Association (KPEA), and to the Kampala Capital City Authority (KCCA), National Water and Sewerage Corporation (NWSC) and Water for People (WfP).

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7 Appendices

7.1 Appendix 1: Stakeholder identification (Tab 2: Stakeholder Tracking Tool)

Table A 1: Identified stakeholders that were directly engaged as part of the SFD production.

Stakeholder #	**Stakeholder group**
Stakeholder 1	Makerere University (academic institution)
Stakeholder 2	NWSC (utility)
Stakeholder 3	NWSC (utility)
Stakeholder 4	NWSC (utility)
Stakeholder 5	KCCA (municipal authority)
Stakeholder 6	UBOS (statistical office)
Stakeholder 7	Emptying service provider

7.2 Appendix 2: Tracking of Engagement

Table A 2: Record of stakeholder engagement based on Tab 3 of the Stakeholder Tracking Tool

Stakeholder	Date of engagement	Purpose of engagement	Summary
Stakeholder 4	08.04.2015	Introduction to SFD Promotion Initiative	Introduction to SFD project and request of data for SFD Production
Stakeholder 7	12.05.2015	Introduction to SFD Promotion Initiative	Introduction to SFD project
Stakeholder 1	30.06.2015	Introduction to SFD Promotion Initiative	Request for potential collaboration
Stakeholder 1	21.07.2015	Data for SFD	Sharing of SFD guidance document, including potential data sources.
Stakeholder 2	28.07.2015	Data for SFD	Request of data for SFD production
Stakeholder 1	15.10.2015	Interview	Questionnaire to receive necessary information for SFD production
Stakeholder 6	19.02.2016	Data for SFD	Request of data for SFD production
Stakeholder 5	19.02.2016	Interview	Confirmation of definitions used for SFD production
Stakeholder 1	21.04.2016	Interview	Interview to receive final confirmation on percentages used for the SFD production
Stakeholder 5	06.06.2016	Interview	Comments on draft report

7.3 Appendix 3: Use of containment technologies

Table A 3: Use of containment technologies in Kampala. Adapted from Fichtner (2008) projected for 2013.

Description	Terrain	Septic tank	VIP latrine	Pit latrine	Pit latrine raised	Public toilet	Other
High-income - Low density	-	75%	20%	5%	0%	0%	0%
Medium-income - Medium density	Valley / areas 1-2	40%	30%	25%	5%	0%	0%
Medium-income - Medium density	Hill / areas 3-4	40%	30%	30%	0%	0%	0%
Low-income - High density	Valley / areas 1-2	20%	35%	40%	5%	0%	0%
Low-income - High density	Hill / areas 3-4	20%	35%	45%	0%	0%	0%
Informal settlements	Valley / areas 1-2	5%	20%	40%	25%	5%	5%
Informal settlements	Hill / areas 3-4	5%	20%	65%	0%	5%	5%