SFD Report

Kabwe
Zambia

Final Report

This SFD Report - Initial level - was prepared by GOPA Infra and BORDA Zambia on behalf of the GIZ Reform of the Water Sector Programme Phase II

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SFD Report Kabwe, Zambia, 2023

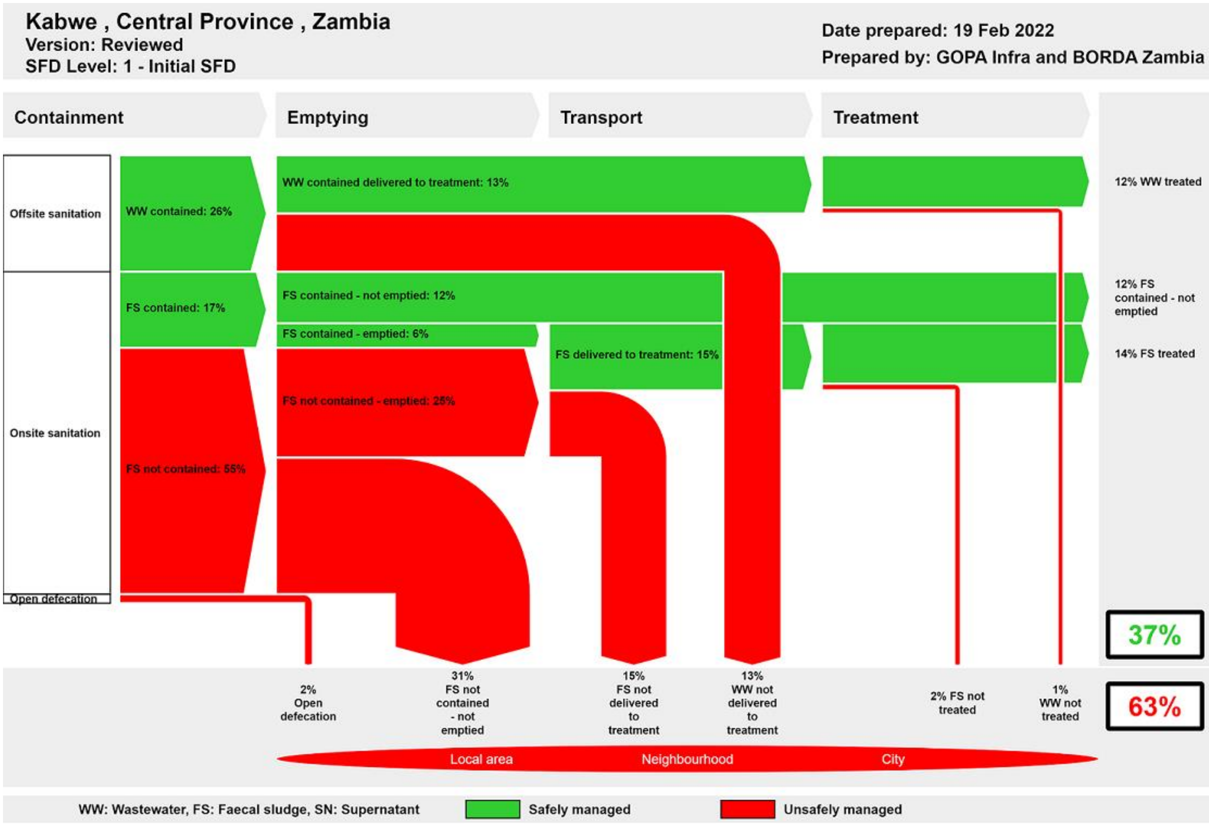
Produced by: GOPA Infra GmbH and BORDA Zambia on behalf of the GIZ Reform of the Water Sector Programme Phase II

Authors' names: Angela Mwila Kapembwa, Phillip Zyambo, Sharon Mulenga, Aubrey Simwambi, Ngenda Situmbeko, James Madalitso Tembo, Johanna Braack

This Executive Summary and SFD Report are available from:

www.sfd.susana.org

1. The SFD Graphic



The SFD Promotion Initiative recommends preparation of a report on the city context the analysis carried out and data sources used to produce this graphic.
Full details on how to create an SFD Report are available at sfd.susana.org

2. Diagram information

SFD Level:

This is an Initial level SFD report for Kabwe town.

Produced by:

This SFD report was produced by GOPA Infra GmbH and BORDA Zambia on behalf of the GIZ Reform of the Water Sector Programme Phase II

Collaborating partners:

- GIZ Zambia Water and Energy Cluster
- Lukanga Water Supply and Sanitation Company
- Kabwe Municipal Council
- Ministry of Health

Status:

Final Initial level SFD Report.

Date of production: 19/02/2022

3. General city information

Kabwe is the administrative capital of Central Province of Zambia and is located on Latitude -14.4228219 and Longitude 28.4455068. According to the utility (NIS) records of 2021, the town has an estimated population of 257,043.

Kabwe Town comprises all housing categories with the informal and low-cost housing accounting for the majority. The town is also famous for accommodating one of southern Africa’s largest peri-urban areas called Makululu compound.

Climatically, Kabwe experiences three seasons in a year – cool and dry from May to August, hot and dry from September to November, and warm and wet from December to April with the the highest amount of rain between November and March. The towns underground water reserves are believed to be mainly charged in two zones namely Kalulu and Mukobeko.

4. Service outcomes

Approximately, 72% of the inhabitants rely on onsite sanitation facilities, 26% are served by offsite sanitation, and the remaining 2% practice open defecation. The population with onsite sanitation use different type of facilities which comprise septic tanks connected to soak pits and all types of pit latrines. The latrines present include those that have not yet filled up, and those which have never been emptied but are covered with soil and abandoned when full.

Most households in informal settlements use pit latrines which are either lined or unlined. Management of old latrines by households was reported to depend on the availability of land for the construction of new ones whenever the old one filled up. Due to the availability of lands for most households, households reported the practice of covering old filled up latrines with soil and rubble after the latrine fills up to a certain degree deemed not conducive for further use.

Sanitation systems in low-, medium- and some high-income areas in Kabwe predominantly have septic tanks connected to soak pits. From tanks that are not emptied, the sludge in the tanks remains in the septic tanks and thickens at the bottom - thereby reducing the capacity and treatment efficiency of the septic tank.

The population with offsite sanitation in the town are connected to the sewer network which is well defined and mostly concentrated around the Central Business District (CBD) and some of the high- and medium- income areas. However, some sections of the low-income areas are also sewered. The sewer network is connected to a total of eight conventional wastewater treatment plants (WWTPs) in the form of stabilisation ponds. However, based on the quantities of wastewater flowing into the ponds, about half of the wastewater is assumed lost in the environment before it reaches the WWTPs.

Groundwater pollution risk varies across the town. In some densely populated low-income areas such as Makululu, households rely on groundwater accessed through shallow wells. This water source is considered not safe due to the pollution risk presented by the sludge in the high number of permeable containment facilities.

Overall, the SFD graphic shows that 37% of the excreta is safely managed while 63% is unsafely managed. Most of the excreta considered to be not safely managed, is in the area of the town where there are permeable containment facilities and there is a 'significant risk' of groundwater pollution.

5. Service delivery context

To guide the vision to achieve universal access to sanitation by 2030, the Government of the Republic of Zambia (GRZ) has put up a very clear policy, regulatory and legal framework for water supply and sanitation services. Important sanitation and environmental protection policies that are in place include: the Zambia Vision 2030; the 7th National Development Plan 2017 – 2021; National Water Supply and Sanitation Policy of 2020, and UN Sustainable Development Goals 2015 – 2030. All these policy documents set clear objectives and targets on sanitation service improvement for both urban, peri-urban and rural areas which include Kabwe Town.

In addition, the Framework for Provision and Regulation of Urban Onsite Sanitation and Faecal Sludge Management and the Framework for Provision and regulation of Rural Water Supply and Sanitation in Zambia sets a robust institutional arrangement that clearly specifies the roles and responsibilities of all key players in the Sanitation Sector. The following are the major sector players:

- Ministry of Water Development and Sanitation (MWDS).
- National Water Supply and Sanitation Council (NWASCO).
- Zambia Environmental Management Agency (ZEMA).
- Kabwe Municipal Council (CMC).
- Water Resources Management Authority (WARMA).
- SWSC.
- Private Service Providers, and
- Cooperating partners such as International Funding Institutions (IFIs) and Non-Governmental Organizations (NGOs).

The roles and responsibilities of all the key sector players are presented in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

In addition, several laws and regulatory tools exist which provide a clear legal and regulatory framework for sanitation at both National and local level. These include the following:

- The Water Supply and Sanitation Act No. 28 of 1997: Mandates NWASCO to regulate water supply and sanitation provision in urban, peri-urban and rural areas as well as provides for the formulation of utility companies who are responsible for water supply and sanitation service provision.

- Local Government Act Chapter 281, Volume 16 of the Laws of Zambia of 1991: Mandates local authorities as providers of water supply and sanitation services in their respective districts. Service provision is delegated to the utility companies who are owned by the local authorities.
- The Public Health Act Chapter 295, Volume 17 of the Laws of Zambia of 1930: Mandates local authorities to enforce public health protection.
- The Environmental Management Act No. 12 of 2011: Mandates ZEMA to license, regulate and enforce environmental safeguards which include treated wastewater effluent discharge standards.
- Water Resources Management Act of 2011: Establishes and mandates WARMA to set, regulate and enforce standards on surface and groundwater quality which are often receiving bodies of treated effluent. It further prescribes the minimum distances for structures including onsite sanitation facilities from natural water resources.
- The Statutory Instrument No. 112 of 2013: Sets limits and standards for environmental protection including licensing of vehicles for transportation of faecal sludge and treatment facilities.
- Statutory Instrument No. 100 of 2011: Provides for local authorities to manage solid waste in the areas of operation. Poorly managed solid waste systems lead to indiscriminate disposed of municipal waste into onsite sanitation facilities, making emptying services challenging.

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6. Overview of stakeholders

The Urban Onsite Sanitation and Faecal Sludge Management – Framework for Provision and Regulation in Zambia launched by the National Water and Sanitation Council (NWASCO) in 2018 creates an enabling environment for sanitation service provision including OSS and FSM. The framework clearly defines the roles and responsibilities of all the key stakeholders as illustrated in the Table 1.

Table 1: Key actors in urban onsite sanitation (Source: NWASCO 2015).

Stakeholder		Responsibility
Group	**Stakeholder**	
Public	MWDS	Policy and Laws
	NWASCO	Service Provision regulation(setting service standards andregulation of emptying andtransportation tariffs)
	ZEMA	Environmental protection regulation (licensing of transportation vehicles/ end use, treatment standards)
	Kabwe Town Council	Enforcement of sanitation systems and public health standards.
Service Providers	LgWSC	Sanitation service provision to rural, urban and peri-urbanareas.
Customer	Households, Commercial and Public institutions.	Responsible for investment in OSS facilities e.g., constructionof standard containment facilities at a household level and connecting to sewer systems.

7. Process of SFD development

Development of this SFD report employed a combination of desk reviews and field-based research. Documents reviewed to extract information on the town population, landscape and practices include reports developed for planned water and sanitation interventions under the LgWSC.

The utility assigned a Focal Point Person (FPP) to work closely with the consultant. The FPP provided support in the extraction of data from utility records and archives. The field visit made use of data collections methods such as semi-structured interviews, observations and questionnaire surveys.

The major limitation in the SFD development was the lack of information on sanitation services along the sanitation service chain at the utility level. There are no records on the type of onsite sanitation containment facilities for the whole of Kabwe District and there are no records on operational activities for sanitation facilities.

Additionally, the utility does not have compiled and well documented data on sanitation operations. Most of the data lies with various station operators at different stations. Hence acquisition of data of the prevailing sanitation condition for different areas required physical visits and in person interviews. This limitation was curbed by collecting the raw data from operators and processing it into manageable and comprehensible data for the generation of the SFD graphic.

Overall, based on the information that was gathered, the Consultant is satisfied that the graphic provides a sufficient depiction of the flow of wastewater and faecal sludge in the town of Kabwe and the developed SFD graphic can be used as a baseline for developing the next tier SFDs.

8. Credibility of data

The data sources for this SFD report are from key informant interviews of the operators and utility staff members including recent reports that were written in line with planned sanitation interventions as the Commercial Utility (CU) level. Therefore, the credibility of the data sources is rated as high.

In order to ascertain the conditional status of CU sanitation facilities, nine Key Informant Interviews (KIIs) and facility field visits were conducted. The KIIs were conducted with operators and staff members working in the CU facilities and at the end of the KII an observatory survey was done. In addition, two reports were reviewed for data sourcing– a feasibility study report and a detailed design report dated 2015 and 2020.

With regard to onsite sanitation facilities, the utility does not have information on sanitation facilities in its communities. Unavailable information but of interest to the development of the SFD report include the type of sanitation facilities, facility construction methods, percentage ratios of particular type of sanitation facilities and current facility management practices. The missing data was the main gap experienced during data collection for this SFD report. Therefore, in cases where data were weak during the process of SFD data collection and graphic generation, assumptions according to SFD development guidelines were made.

One of the major assumptions that was made was on the classification of pit latrines as either semi-lined or unlined. Another assumption concerned the pollution of groundwater, which was assumed to be high because of the high percentage of population that rely on onsite sanitation systems. This assumption was reached because the previous practice was to burry filled up pit latrines and dig new ones, and since the newly introduced emptying service is not yet common in the communities, it is likely that this practice still prevails.

There is still a data gap about the difference between sludge produced and sludge that gets to the sewage ponds. There is also need for detailed studies on the percentage of toilets and septic tanks that are emptied.

9. List of data sources

The following data sources were consulted to develop this executive summary:

- Gauff Ingenieure, 2015. Feasibility Study Report for Lukanga Water and Sewerage Company, Kabwe: s.n.
- Korea Engineering Consultants Corp (KECC); SAMAN Corp; Andosa Consulting, 2020. Consulting Services for the Detailed Feasibility Studies and Designs of the Water Supply and Sanitation Improvements in the Prioritized Urban Centers of North Western, Southern and Lukanga Water Supply and Sanitation Companies, Kabwe: s.n.

SFD Kabwe, Zambia, 2023

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Abbreviations

BMZ	German Federal Ministry of Economic Cooperation and Development
BORDA	Bremen Oversees Research and Development Association
CBD	Central Business District
CSO	Central Statistics Office
CU	Commercial Utility
FPP	Focal point Person
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
KECC	Korea Engineering Consultants Corp
KII	Key Informant Interview
KTC	Kabwe Town Council
LgWSC	Lukanga Water Supply and Sanitation Company
MLG	Ministry of Local Government
NUSS	National Urban and Peri-Urban Sanitation Strategy
NUWSSP	National Urban Water Supply and Sanitation Program
NWASCO	National Water Supply and Sanitation Council
OD	Open Defaecation
SFD	Shit Flow Diagram
WSS	Water Supply and Sanitation
WWTP	Wastewater Treatment Pond

1 City context

Kabwe, formerly called Broken Hill Town, is the administrative capital of Central Province including six other districts namely Kapiri Mposhi, Mkushi, Mumbwa, Serenje, Chisamba, and Chibombo. The town is located at latitude -14° 26' 48.84" S and longitude 28° 26' 47.18" E and lies between 1,170 and 1,205 metres above mean sea level. Kabwe is located about 137 kilometres from Zambia's capital city, Lusaka. Major geographic features surrounding Kabwe include the Mulungushi River catchment on the North and East, the Mwombashi River bed on the South and the Lukanga swamp depression on the West.

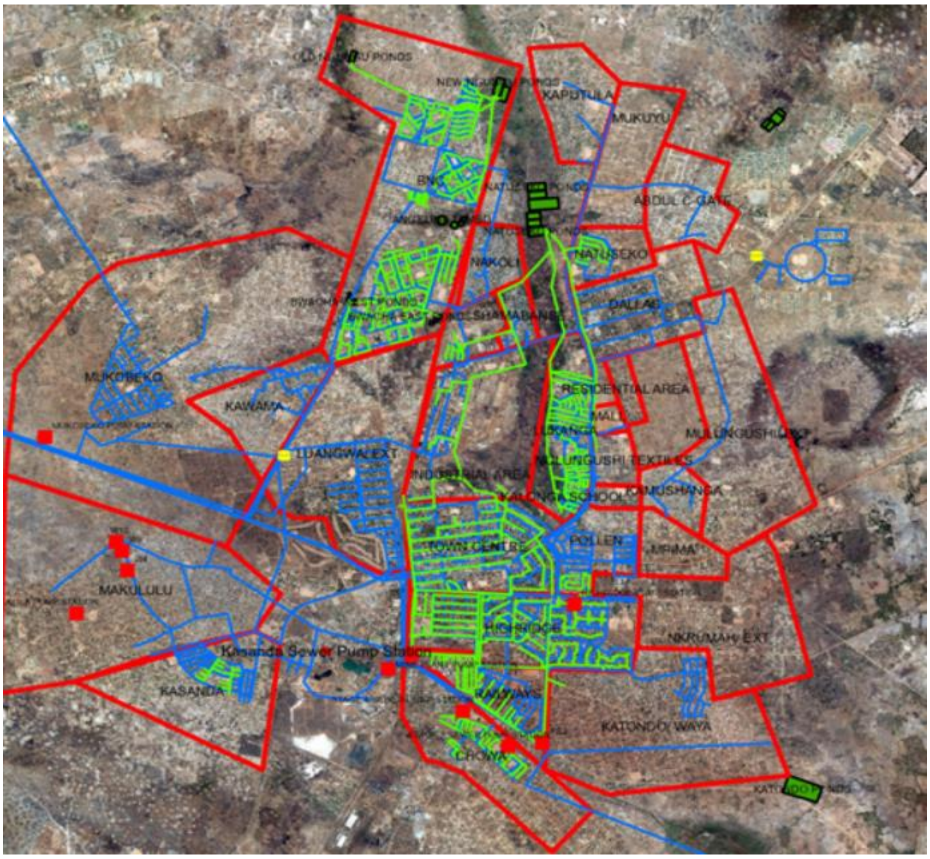

Figure 1: Location of Kabwe town and municipal boundaries (Source: Gauff Ingenieure (2015)).

The town is one of Zambia's oldest mining towns with lead and zinc being the major mined minerals. Consequently, the town is well planned, distinguishing the mine boundaries and the town council areas and jurisdiction with regards to housing, sewerage coverage as well as water connections. The two sides of the town are separated by a railway line and the main T2 highway referred to as the Great North Road. The town comprises all housing categories with the informal and low-cost housing accounting for the majority (44% and 29%, respectively). It is also known for one of the largest peri-urban area in Southern Africa called Makululu compound.

1.1 Climate

Temperatures in Kabwe range between 14°C and 28°C, and sunshine hours range between 9 and 12 hours per day. The highest temperatures are recorded between October and December while the lowest temperatures are around June and July. The town lies within the rain belt and experiences the highest amount of rain between November and March. The main groundwater recharge zones are at Kalulu, Mukobeko and Mulungushi, where most of the fresh water is extracted, treated and distributed.

1.2 Population

According to 2010 National Census on population and housing, the town had a population of 202,914 with an average population growth rate of 1.4% per annum for the period 2020 to 2025. According to the utility (NIS) records, the estimated population for the year 2021 stands at approximately 257,043.

2 Service Outcomes

2.1 Overview

This section presents the range of infrastructure technologies, methods and services designed to support the management of wastewater and faecal sludge through the sanitation service chain.

The data provided by the Commercial Utility (CU) for the study does not include the contribution of excreta from the transient population using public toilets, institutions, commercial and industrial areas, restaurants as well as the hospital and churches. Therefore, in this SFD report, it is assumed that all excreta is only emanating from household facilities.

However, since the transient population is mostly users who live in the town, this assumption does not significantly alter the outcomes of this SFD. Nevertheless, further study is recommended to confirm this assumption.

The SFD graphic was developed using the selection grid in Figure 2.

List A: Where does the toilet discharge to? (i.e. what type of containment technology, if any?)	List B: What is the containment technology connected to? (i.e. where does the outlet or overflow discharge to, if anything?)									
	to centralised combined sewer	to centralised foul/separate sewer	to decentralised combined sewer	to decentralised foul/separate sewer	to soakpit	to open drain or storm sewer	to water body	to open ground	to 'don't know where'	no outlet or overflow
No onsite container. Toilet discharges directly to destination given in List B		T1A1C2			Significant risk of GW pollution Low risk of GW pollution					Not Applicable
Septic tank					T2A2C5 T1A2C5					
Fully lined tank (sealed)					Significant risk of GW pollution Low risk of GW pollution					
Lined tank with impermeable walls and open bottom	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution	Significant risk of GW pollution Low risk of GW pollution					Significant risk of GW pollution Low risk of GW pollution
Lined pit with semi-permeable walls and open bottom	Not Applicable									Significant risk of GW pollution Low risk of GW pollution
Unlined pit										Significant risk of GW pollution Low risk of GW pollution
Pit (all types), never emptied but abandoned when full and covered with soil										T2B7C10 T1B7C10
Pit (all types), never emptied, abandoned when full but NOT adequately covered with soil										
Toilet failed, damaged, collapsed or flooded										
Containment (septic tank or tank or pit latrine) failed, damaged, collapsed or flooded										
No toilet. Open defecation	Not Applicable								T1B11 C7 TO C9	Not Applicable

Figure 2: SFD selection grid.

2.1.1 *Off-site sanitation*

According to the annual benchmarking data, 26% of the population in Kabwe are serviced by offsite sanitation. The sewer network together with all the pond systems for Kabwe Town are operated and managed by Lukanga Water Supply and Sanitation Company (LgWSC). The *status quo* of offsite sanitation systems is described below.

Sewer Network

The sewerage systems in Kabwe consists of six sewage stations, five of which serve as sewage pump stations lifting pumping wastewater into the main trunk sewer line and one (located in Pollen) serves as a communal septic tank (Figure 3). The pumping stations were all accessible and had an operator present during the field visits. However, they all have dilapidated infrastructure and all had only one operational pump working without any back-up pump (Figure 4). Additionally, there are no electricity back-up options to supplement power outages implying that during periods of no power supply, the pumping stations discharge into the environment.

Wastewater that is lifted to the main sewer line flows under pressure to Katondo stabilization ponds. The wastewater that accumulates at the communal septic tank is periodically pumped out using the utility vacuum truck. The sucked septage is transported to Bwacha North (Angelina Tembo) Sewage Ponds.

Figure 3: Pollen pimp station currently operating as a communal septic tank (Source: Author).

Figure 4: State of selected sewage pump station in Kabwe. LHS: PS1 Sewage Pump Station showing a damaged access ladder to the inlet chamber and an insert of a damaged screen; RHS: PS2 Sewage Pump Station with flooding inlet channel during a period of ZESCO power outage (no standby power supply (Source: Author).

Other common problems at the pump stations include inadequate capacity to operate and record daily activities, vandalism of sewer pipe components and flooding. Table 1 gives a summary of the pump stations giving a description of the areas that are serviced and the mode of wastewater flow, their design capacities and their operational status.

Table 1: Description and status of pump stations in Kabwe Town.

Pump station	Description of means of flow and areas serviced	Design Capacity/ Design Volume	Status
Kasanda pump station	Wastewater flows by gravity from Kasanda mine areas. Wastewater is pumped to PS1	151m^3/hr + 151m^3/hr standby	Operational
Pump station 1 (PS1)	Receives wastewater pumped from Kasanda catchment as wastewater flowing by gravity from the Central Business District (CBD)	200m^3/hr + 400m^3/hr standby	Operational
Pump station 2 (PS2)	Wastewater flows by gravity from Railways catchment. Wastewater is pumped to main sewer trunk line	200m^3/hr + 200m^3/hr standby	Operational
Stage 2 pump station	Wastewater flows by gravity from Chowa catchment. Wastewater is pumped to main sewer trunk line	537m^3/hr including standby	Operational
Stage 4 pump station	Wastewater flows by gravity from Waya catchment. Wastewater is pumped to main sewer trunk line	537m^3/hr including standby	Operational
Pollen pump station	Wastewater flows by gravity from Single Quarters catchment. It is them pumped out using a vacuum truck to Bwacha North ponds.	11m^3/hr + 11m^3/hr standby	Not operational

Generally, existing data on the state of the network was not up to date. The functionality of the system was an issue that needs further investigations. However, what is clear is that there are blockages and leakages in the sewerage systems upstream of the Wastewater Treatment

Plants (WWTPs). This assertion is based on observations made on the system. To start with, it was found on several cases that wastewater arriving at the treatment plants was clear and devoid of suspend solids (Figure 5). This was indicative of solids being retained upstream in the network. This phenomenon in wastewater collection is experienced when there are blockages in the system. Secondly, low flows were observed at the inlets of most ponds (Table 1). In some cases, there was no wastewater reaching the treatment plants as the case was for Old Ngungu Stabilisation Ponds (Figure 5). A conclusion can be drawn from the low flows at the inlets that most of the wastewater is lost in the environment before reaching the stabilization ponds.

Figure 5: Evidence of blockages and leakages in the systems. LHS: Clear sewage devoid of suspended solids reaching the Natuseko Ponds; RHS: The Old Ngungu Ponds with completely no flows. (Source: Author).

During the surveys, it was also observed that there were a lot of agricultural activities along the major wastewater conveyance lines, especially in the vicinity of wastewater treatment facilities (Figure 6). Anecdotal data from interviews with stakeholders indicated that there are a lot of wastewater diversions from the systems into the fields for irrigation. The practice was reportedly rampant during the dry season.

Figure 6: Agricultural activities along the main sewer lines in Kabwe. LHS: Agricultural activities along the Natuseko Trunk Sewer; RHS: Agricultural activities along the Ngungu Trunk Sewer. (Source: Author).

Sewer leakages and the inherent blocking of sewage results in the part of the sewage not reaching the intended treatment plants. However, there are no studies to quantify how much sewage leaks out. The need to cover the information gap is made complex by the absence of flow measuring devices along the inlet channels/pipes to the treatment plants or at the treatment plants.

Therefore, in this study, the estimation of how much wastewater reaches the treatment plants was based on the SFD development guideline. This implies that if this SFD is to be upgraded to higher versions, a comprehensive study to cover data gaps need to be done.

Treatment System

All the treatment plants servicing Kabwe Town comprises facultative ponds and several maturation ponds receiving wastewater from sewered communities through gravitational flow. Two plants were implemented with anaerobic pre-treatment facilities which are either septic tanks or anaerobic digesters upstream of the facultative ponds; the Katondo ponds have an anaerobic digester upstream of the ponds while the Natuseko and Old Ngungu Ponds have septic tanks (Figure 7).

Figure 7: Anaerobic pre-treatment facilities. RHS: an anaerobic tank upstream of the Katondo Ponds; LHS: a septic tank upstream of the Old Ngungu Ponds. (Source: Author).

During the survey, almost all the ponds visited were observed to have obsolete infrastructure with low wastewater inflows. In addition, the infrastructure was over-grown with grass, and as such were inaccessible for most parts especially the outlet points (Figure 8). This prevented observation of most of the end points of the treated wastewater disposal.


Figure 8: General state of sewage ponds in Kabwe. LHS: Blocked Old Ngungu inlet Channel; RHS: Natuseko Ponds overgrown with weeds and with a blocked the inlet. (Source: Author).

Table 2 presents a summary of the ponds with descriptions of serviced areas, wastewater inflow mode, design capacities and the operational status.

Table 2: Description sewage treatment plants in Kabwe Town.

Pond system (Sewer shed)	Description of means of flow and areas serviced	Design Capacity/ Design Volume	Status
Katondo ponds	Receives wastewater pumped from the main sewer trunk line	16,800m^3	Receives flow, overgrown grass around ponds and at outlet
Natuseko Ponds	Wastewater flows by gravity from Mulungushi textiles catchment, Industrial area catchment, Pollen catchment, Lukanga catchment, Natuseko catchment, Mwalala catchment and Town centre catchment.	9,600m^3	Receives flow, overgrown grass around ponds and at outlet
Old Ngungu ponds	Wastewater flows by gravity from Old Ngungu catchment.	1,680m^3	No flow observed at inlet, ponds were dry
New Ngungu ponds	Wastewater flows by gravity from Old and New Ngungu catchment and Chimanimani catchment.	7,400m^3	Low flow at the inlet, inaccessible outlet
Bwacha East ponds	Wastewater flows by gravity from Bwacha catchment.	1,900m^3	Low flow at the inlet, inaccessible outlet
Bwacha West ponds	Wastewater flows by gravity from Bwacha catchment.	1,900m^3	Low flow at the inlet, inaccessible outlet
Bwacha North (Angelina Tembo) ponds	Wastewater flows by gravity from Bwacha catchment.	2,500m^3	Low flow at the inlet, inaccessible inlet and outlet
Mutwe Wa Nsofu oxidation ponds	Not operational	800m^3	Not operational

To check on the treatment compliance of the discharged wastewater, the utility does not have laboratory facilities for analysing wastewater. Therefore, there is no quantitative data on the quality of the effluent going into the environment. However, the lack of wastewater outflow from the many utility wastewater treatment facilities makes it impossible to establish wastewater treatment levels, even when laboratory facilities for analysis of the effluent could be available.

In many facilities, there is no discharge from the ponds due to low wastewater inflow for treatment. However, there is no quantitative data on the quality of the effluent and thus, treatment efficiency in the generation of this SFD was assumed to be 90%. This assumes that with no effluent flowing into the environment, the wastewater retention time for adequate treatment facilities can be assumed infinite. This is also true from the perspective of compliance to effluent standard discharged into the environment since the ponds are not discharging into the surrounding environment, thereby not polluting the environment. However, there is no quantitative data on the quality of the effluent, so there is an assumption of 90% compliance.

2.1.2 Onsite sanitation

Onsite sanitation facilities comprise most of the sanitation facilities. The population relying on on-site sanitation is approximated at 72%. Two predominant on-site sanitation facilities used in the town include septic tanks connected to soak pits and pit latrines. However, there are no data that exists to distinguish the specific types of pit latrines. Nonetheless, an assumption made and based on observations of some latrines in some areas was that semi-lined and unlined pit latrines types of pit latrines are the mostly implemented types.

Services for households requiring emptying of their filling latrines were reported to be existing in the utility for over a year ago. The applied pit latrine emptying business model is replicated from the model employed in the city of Lusaka. The emptying system is managed by LgWSC working in partnership with a private operator. Logistics for emptying including transport are provided by LgWSC whilst the private operator provides the labour to carry out the emptying services.

Removal of sludge from the containment facilities is through the use of modified garden tools. The desludged faecal sludge is put in 60L barrels which are then loaded on a light truck for transportation to open drying beds located at PS2 where the sludge is treated through the process of drying (Figure 9). Payment to the private operator for the services is based on the volume of sludge that is emptied which is measured through the number of 60L barrels that are emptied.

Since it is a formal emptying system, minimum safety standard requirements are in place to ensure that emptiers and the environment are safe. Some of these requirements include ensuring that all workers are provided with full Personal Protective Equipment (PPE) and ensuring that all workers undergo periodic medical check-ups. Workers are also provided with disinfectants to ensure adequate sanitisation of all areas where emptying services are provided and all equipment used are adequately sanitised.

Figure 9: Faecal sludge emptying and treatment in Kabwe. LHS: Barrels used to transport emptied faecal sludge; RHS: The faecal sludge drying bed at PS2. (Source: Author).

The pit emptying service model is still evolving as the employed one is on pilot. Therefore, the population currently being serviced is negligible. At the time of the study, no statistics were available on the exact number of households that had been serviced. It should also be noted that pit emptying is still not a common practice as communities are still acquainting themselves to this new paradigm.

For septic tank emptying services, there is currently one 10 m^3 vacuum truck that also serves the towns under the CU jurisdiction in Central Province. The capacity of the CU tank is deemed insufficient to meet the demands of the services. This deficiency causes most septic tanks to be unserved and remain filled with septage and thereby affects their normal operations.

2.1.3 Open defecation (OD)

There are households mostly in the peri-urban areas without any forms of sanitation facilities. This population is assumed to be on open defecation. The estimated population on open defecation is around 2%. However, this is an area that would need confirmatory studies as there are a lot of uncertainties in the estimation.

2.2 SFD Matrix

The Kabwe town SFD was developed based on available sanitation data from reports and field visits. Based on this data, the SFD graphic of sanitation systems was generated with the application of the SFD matrix (Table 3).

Table 3: SFD Matrix.

Kabwe , Central Province , Zambia, 19 Feb 2022. SFD Level: 1 - Initial SFD
Population: 257043
Proportion of tanks: septic tanks: 100%, fully lined tanks: 100%, lined, open bottom tanks: 100%

Containment						
System type	Population	WW transport	WW treatment	FS emptying	FS transport	FS treatment
	Pop	W4a	W5a	F3	F4	F5
System label and description	Proportion of population using this type of system (p)	Proportion of wastewater in sewer system, which is delivered to centralised treatment plants	Proportion of wastewater delivered to centralised treatment plants, which is treated	Proportion of this type of system from which faecal sludge is emptied	Proportion of faecal sludge emptied, which is delivered to treatment plants	Proportion of faecal sludge delivered to treatment plants, which is treated
T1A1C2 Toilet discharges directly to a centralised foul/separate sewer	26.0	50.0	90.0			
T1A2C5 Septic tank connected to soak pit	11.0			50.0	50.0	90.0
T1B11 C7 TO C9 Open defecation	2.0					
T1B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow	6.0					
T2A2C5 Septic tank connected to soak pit, where there is a 'significant risk' of groundwater pollution	49.0			50.0	50.0	90.0
T2B7C10 Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	6.0					

2.2.1 Distribution of containment technologies

Table 4 shows the distribution of containment systems for preparation of the SFD graphic.

Table 4: Distribution of containment systems for preparation of the SFD graphic.

Containment technology	Total (%)	SFD classification
Offsite Sanitation	**26%**	
User interface discharges directly to a centralised foul/separate sewer	26%	T1A1C2
On-site Sanitation	**72%**	
Septic tank connected to soak pit where there is a 'significant risk' of ground water pollution	49%	T2A2C5
Septic tank connected to soak pit	11%	T1A2C5
Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow	6%	T1B7C10
Pit (all types), never emptied but abandoned when full and covered with soil, no outlet or overflow, where there is a 'significant risk' of groundwater pollution	6%	T2B7C10
Open defecation	**2%**	**T1B11 C7 TO C9**

Offsite sanitation: 26% of the population is connected to centralised separate sewer systems. An unknown percentage of the sewerage network within the Katondo Sewage Stabilisation Ponds sewer shed delivers sewage by gravity to the five respective pumping stations before being pumped to the ponds whilst the other networks servicing the other sewer sheds conveys wastewater entirely by gravity (Tables 2 and 3). Problems encountered in the sewer network include inadequate capacity to operate and record daily activities, vandalism of sewer pipe components, flooding, blockages and leakages. However, there are no quantitative data. Thus, it has been estimated that half of the wastewater is lost due to these facts and hence, the percentage of wastewater that is delivered to treatment was set to 50% (W4a = 50%).

In terms of wastewater treatment, there is no quantitative data on the quality of the effluent from the WWTPs going into the environment. It was observed that there was no effluent flowing into the environment, so the wastewater retention time for adequate treatment facilities can be assumed infinite. This can be translated into assuming a treatment efficiency of 90% and setting variable W5a to 90%.

Onsite sanitation: Most of the population (72%) are dependent on onsite sanitation systems for excreta disposal and treatment. These are predominantly septic tanks and pit latrines of different characteristics.

Septic tanks: A cumulative total of 60% of the population are serviced by septic tanks connected to soak pits where 49% out of it present a high risk of groundwater pollution. However, it was not certain what kind of design is used to construct the implemented septic tanks; that is whether or not it has two compartments or just acts as a lined tank. Nonetheless, all informants referred to it as a septic tank. There were also no statistics on the proportion of septic tanks emptied either formally or informally including modes of disposal although it was indicated that all septage emptied formally ends up at the sewage treatment plants.

Pit latrines: There are no available data to identify the various types of pit latrines that exist. Therefore, for the generation of this SFD graphic, the assumption made was that there are various types of pit latrines. The accumulative total of the latrines from sanitation facilities is approximately 12%. Some latrines are new dugouts, some are old latrines with reports of them having never been emptied before and others are old abandoned latrines. Abandoning filled up latrines is done by topping and covering them with soil. Some pit latrines were reported to never fill up and assessments on them having sludge outflows revealing non-existent lead to the conclusion of them possibly to be soaking their content underground, therefore, presenting a 'significant risk' of groundwater pollution.

2.2.2 Emptying of onsite technologies

There were no statistics on the proportion of septic tanks emptied either formally or informally. So, as suggested by the SuSanA guidelines on the absence of data, it was estimated that 50% of the septic tanks (T1A2C5 and T2A2C5) have been emptied (variable F3 = 50%).

2.2.3 Transport of FS from onsite technologies

There were no data on the percentage of the emptied FS that is delivered to treatment. So, as suggested by the SuSanA guidelines on the absence of data, it was estimated that 50% of emptied FS reaches treatment (variable F4 = 50%).

2.2.4 Treatment of FS from onsite technologies

It was indicated that all septage emptied formally ends up at the sewage treatment plants and treated in open drying beds. In the absence of more accurate data, it was also estimated that treatment efficiency was 90% in the same way as for wastewater treatment, so variable F5 was set to 90%.

Open defecation: There is a lot of uncertainty around the actually proportion of open defecation. During the generation of the SFD graphic, it was estimated that the proportion of population that could not be accounted for as using any of the identified sanitation facilities was standing at 2%.

2.2.5 Risk of groundwater contamination

There were no data on hydrogeological conditions. However, through Key Informant Interviews (KIIs) and observations made, the general geological formation around Kabwe town is siltstone and sandstone. it was also noted that there are three areas where water for the whole town is sourced namely Mukobeko well field, Kalulu well fields and Mulungushi Dam. A number of boreholes are dotted around the well fields with some boreholes at depths of approximately sixty metres.

On the lateral separation distance between sanitation facilities and groundwater sources, it was evident from the field surveys that the distances were mostly less than 10m especially in peri-urban areas where groundwater usage is prominent. However, in other areas, it was not possible to make a conclusive assessment.

2.2.6 Certainty and uncertainty levels in collected data

There remains a lot of uncertainty with regards to the type of onsite sanitation facilities that exist because there have never been no sanitation studies that have dug in deeper into this topic. Additionally, there is uncertainty in the operational state of the offsite sewer network and the volumes of wastewater that leak into the environment.

There is need to clearly ascertain the number of pit latrines that have been emptied since the commencement of the emptying service by the utility as well as measure the acceptance of this service since commissioning. In addition, very little data are available on hydrogeological characteristics in Kabwe town including data on location of water points with respect to sanitation facilities henceforth most of the data on the subject was based on assumptions.

Currently, there have been no studies that identify the types of onsite sanitation containment facilities in Kabwe town, hence making it difficult to establish the specific containments that are in use. Therefore, the generation of this SFD graphic inferred results and conclusions from descriptions given at each stage along the sanitation service chain working our way towards an understanding of the faecal flows, using information such as community practices, sanitation interventions and information gathered from interviews.

2.3 Summary of assumptions

Offsite sanitation systems:

- ✓ 26% of the population in Kabwe are serviced by offsite sanitation. The sewer network however is in an unknown condition state with an approximated 50% of the wastewater collected reaching the treatment facilities (W4a = 50%).
- ✓ The treatment facilities are in acceptable operational condition in relation to the wastewater they treatment volumes. The collected wastewater by the treatment facilities is in low quantities and nothing flows out of the ponds. It therefore follows that all the excreta received at the waste water stabilisation Ponds (WWSP) is adequately treated with a treatment efficiency of 90% (W5a = 90%).

Onsite sanitation systems:

- ✓ The proportion of Faecal Sludge (FS) in septic tanks was set to 100% and the proportion of FS in lined tanks with impermeable walls and open bottom and pits was set to 100% according to the relative proportions of the systems in the municipality, as per the guidance given in the Frequently Asked Questions (FAQs) in the Sustainable Sanitation Alliance (SuSanA) website.
- ✓ Variable F3 for all on-site sanitation systems (T1A2C5 and T2A2C5) has beet set to 50% since there is no accurate data available.
- ✓ It is assumed that half of the FS emptied is delivered to treatment (F4 = 50%) and all the FS delivered to treatment is treated (F5 = 90%).

2.4 SFD graphic

Figure 10 shows the SFD graphic where 37% of the excreta is safely managed while 63% is unsafely managed.

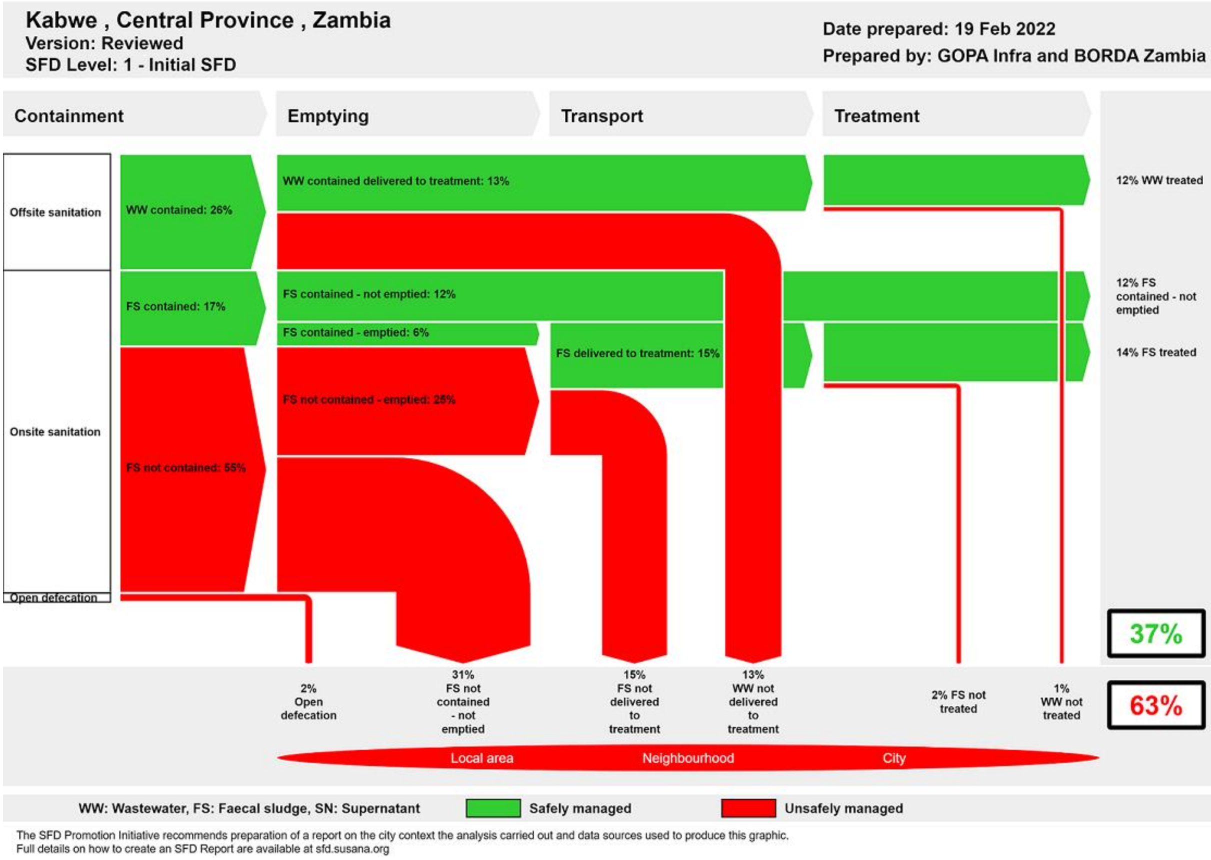

Figure 10: SFD Graphic for Kabwe.

Offsite sanitation systems are well defined around the Central Business District, in some of the high and medium cost areas, as well as in some sections of the low-cost areas. Each sewer network is connected to one of the eight conventional wastewater treatment plants (WWTPs) in form of sewage stabilisation ponds. However, there were insufficient data to adequately quantify or estimate the quantity of wastewater reaching the waste stabilization ponds. Therefore, recommended estimates from the SFD development guidelines of 50% wastewater to be reaching the WWTPs was applied. From the 26% of the population connected to the sewer network, 13% of the population have their wastewater lost in the environment before reaching the ponds. Observations also revealed a presence of high levels of blockages and leakages in the systems. Agricultural activities along trunk sewers and near and around the ponds were also prevalent in the town leading to a conclusion that some of the wastewater is blocked to flow into agriculture fields and plantations for irrigation purposes as highlighted in section 2.2 on 'onsite sanitation'. The wastewater reaching the treatment plants (13%) was assumed to be treated with a 90% efficiency based on the premise that all the treatment facilities are non-conventional providing infinite retention time and hence 90% treatment (Refer to section 2.2 under offsite sanitation).

Kabwe has approximately 72% of its population relying on onsite sanitation systems. Therefore, established during the study was that most of the inhabitants rely on onsite sanitation facilities that comprise septic tanks connected to soak pits and various pit latrines that have never been emptied but some have been abandoned when full.

The SFD graphic presents that 17% of the population are on onsite systems have their faecal sludge contained. Of this population, 12% have their faecal sludge safely managed along the whole service chain. This population is the ones represented by households connected to systems with a septic tank and soak pit in areas where there is low risk of groundwater pollution and have not been emptied. The low, medium and some high- cost areas have predominantly septic tanks connected to soak pits. The utility currently operates with one vacuum truck of 10 cubic metre capacity to service all the seven towns in Central Province. This is insufficient to cater for the emptying demand in Kabwe. However, most of the sludge remains in the septic tanks, solidifies at the bottom and reduce the capacity and treatment efficiency of the septic tank. Thus, as these systems fill up, they would need emptying services.

On the other hand, 55% of the population do not have their faecal sludge contained, out of which 25% corresponds to FS emptied and 31% to FS not emptied. Pit latrine emptying services was introduced to the utility and has been operational for approximately one year. Therefore, it is still new to the communities and as such not widely practised. The previous practice when a pit latrine is full was, and to a certain degree still is, is to cover it and dig a new one. The SFD graphic also highlights that there is a risk of contamination though this FS not contained - not emptied because some of the areas are prone to groundwater pollution and in some areas, there are shallow wells where communities abstract their drinking water.

Open defecation is estimated at 2%. There were very few households observed in the two recharge zones Mukobeko and Kalulu. However, in areas such as Makululu, digging of shallow wells in the community poses a very high risk of groundwater pollution due to the numerous number pit latrines in this densely populated area. In relation to the SFD graphic, the cumulative percentage of population whose faecal sludge ends up in the environment poses a high risk of ground and surface water pollution.

3 Service delivery context

3.1 Policy, legislation and regulation

The Government Republic of Zambia (GRZ) has put up in place clear policies, regulations and legal frameworks for water supply and sanitation services to create an enabling environment to attain universal access to sanitation for all by 2030. The sections below outline the policy, institutional/ regulatory and legal frameworks for sanitation which applies at both national and local levels.

3.1.1 Policy

The following policies have been put in place to provide direction and guidance on the vision to achieve the universal access to safely managed sanitation for all by 2030:

The Zambia Vision 2030: the vision identifies inadequate access to safe water supply and sanitation as one of the human well-being and social development aspect that needs to be improved for Zambia to attain the aspiration to become a prosperous middle-income country by 2030. In this regard, the vision sets target to improve access to adequate, appropriate and environmentally friendly sanitation for at least 90% of Zambians by 2030.

The 7th Development Plan 2017 – 2021: Outlines the intended five-year developmental outcomes and goals to achieve the vision 2030. Thus, the plan outlines strategies and programs that are aimed at improving access to safely managed sanitation at all levels in Zambia.

National Water Supply and Sanitation Policy of 2020: The policy was developed based on the vision 2030 and the sustainable development goals and its implementation shall be through the National Development Plans. The policy sets clear and coherent policy measures that guide the improvement of access to adequate and safely managed sanitation for all. One of the objectives of the policy is to provide the legal and institutional framework for sanitation service delivery in Zambia.

UN Sustainable Development Goals 2015 – 2030: Zambia is a member of the UN and all developmental programs and policy documents in the water supply and sanitation sector are aligned to the Sustainable Development Goals (SDGs) No. 6 and its targets.

National and Local Programs: The National Urban Water Supply and Sanitation Program (NUWSSP, 2011 – 2030) enables all urban residents, commerce, institutions and industry to have access to sanitation and utilize it in an efficient and sustainable manner for improved health, well-being and livelihood by 2030. Specifically, the National Urban and Peri-Urban Sanitation Strategy (NUSS, 2015- 2030) provides a framework for financing and implementing the sanitation component of the NUWSSP and has set a target to “provide adequate, safe and cost-effective sanitation services to 90 percent of the urban population by 2030”. To achieve this target, one of the objectives is to improve access to sanitation and safely manage sanitation systems so as to reduce the incidence of water borne diseases outbreaks such as cholera.

All these policy documents and programs have set clear objectives, targets and an enabling environment on sanitation service improvement for both urban, peri-urban and rural areas which includes Kabwe District.

3.1.2 *Institutional roles*

The Framework for Provision and Regulation of Urban Onsite Sanitation and Faecal Sludge Management (FSM) and the Framework for Provision and regulation of Rural Water Supply and Sanitation in Zambia sets a robust institutional arrangement that clearly specifies the roles and responsibilities of all key players in the Water Supply and Sanitation Sector in Zambia. Figure 11 shows the institutional and regulatory framework and outlines the various roles and responsibilities of the key sector players in Zambia.

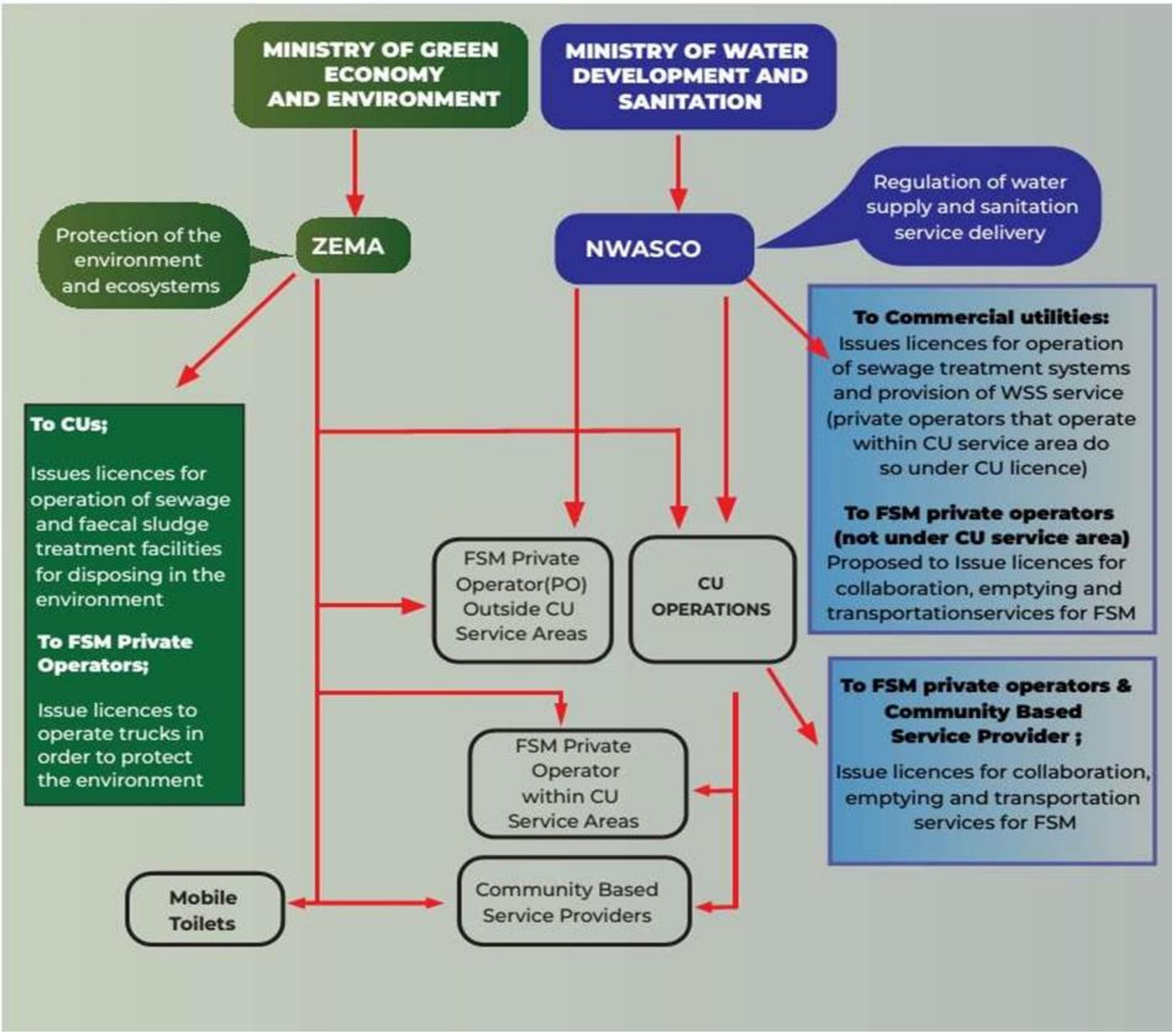

Figure 11: Regulatory Framework for Provision of Sanitation Services (Adapted from NWASCO, 2018).

At the local level, a number of key players exist. These are explained in the ensuing sections.

Kabwe Town Council (KTC) - Under the direction of Ministry of Local Government (MLG), Kabwe Town Council (KTC) focuses on the enforcement of Ministry of Health's Hygiene Regulations and the development of by-laws on sanitation service provision through the Public Health Departments. KTC also holds the majority of the shares in LgWSC and sits on the board as well as delegates' LgWSC for water supply service and sanitation provision as per the Water Supply and Sanitation Act No. 28 of 1997. KTC, through Environmental Health Officers and Health Inspectors, are mandated to enforce and regulate the sanitation relevant laws related to the Public Health Act (Drainage and Latrine), Regulation 1994 (Amended 2006) related to collection, transportation and treatment of wastewater. It is also the mandate of KTC to provide other services that relate to the quality of the urban environment and therefore have a broader responsibility for sanitation that also includes solid waste management and storm-water drainage system for areas within Kabwe Town.

It is the responsibility of KTC to issue business levy licenses to all businesses operating in the city including service providers in solid and liquid waste management. There is however a weak enforcement when it comes to registration of businesses providing OSS and FSM services in Kabwe Town.

Lukanga Water Supply and Sanitation Company (LgWSC) - LgWSC is the CU delegated by KTC to provide water supply and adequate sanitation services to rural, urban and informal areas of Kabwe District. The regulating body responsible to oversee LgWSC is overseen and regulated by the National Water and Sanitation Council (NWASCO) and manages the current water supply and sanitation infrastructure for the town.

National Water Supply and Sanitation Council (NWASCO) - According to the Framework for Provision and Regulation of Urban Onsite Sanitation and Faecal Sludge Management, regulation of sanitation service provision (including OSS and FSM) in Kabwe town is done through new licensing conditions of 2018 issued to LgWSC by NWASCO. Under the licensing conditions, any private operator providing sanitation services (e.g. emptying of OSS facilities) within the LgWSC designated service area will do so under a delegated management contract with LgWSC. Private operators providing services outside the service areas of LgWSC need to obtain a permit directly from NWASCO (NWASCO, 2018).

Zambia Environmental Management Agency (ZEMA) - ZEMA is responsible for applying the legal framework for the protection of the environment and the control of pollution. Under the Environmental Management Act, no 12 of 2011, ZEMA regulates discharges into the environment and promotes water pollution monitoring and prevention programs based on enforceable water quality guidelines and standards. ZEMA is also responsible for issuance and enforcement of waste management licenses to any individual or entity who wishes to collect and transport domestic and commercial waste in the city for environmental protection.

3.1.3 Standards

Several laws and regulatory tools exist which provide a clear legal framework for sanitation at both National and local level. These include the following:

The Water Supply and Sanitation Act No. 28 of 1997: Mandates NWASCO to regulate water supply and sanitation provision in urban, peri-urban and rural areas as well as provides for the formulation of utility companies who are responsible for water supply and sanitation service provision.

Local Government Chapter 281, Volume 16 of the Laws of Zambia: Mandates local authorities for provision of water supply and sanitation services in the respective districts. Service provision is delegated to the utility companies who are owned by the local authorities.

The Public Health Act Chapter 295, Volume 17 of the Laws of Zambia of 1930: Mandates local authorities to enforce public health protection.

The Environmental Management Act No. 12 of 2011: mandates ZEMA to license, regulate and enforce environmental safeguards which includes treated wastewater effluent discharge standards.

Water Resources Management Act of 2011: Establishes WARMA to set, regulate and enforce standards on surface and ground water quality which are often receiving bodies of treated effluent. It further prescribes the minimum distances for structures including onsite sanitation facilities from natural water resources.

The Statutory Instrument No. 112 of 2013: Sets limits and standards for environmental protection including licensing of vehicles for transportation of faecal sludge and treatment facilities.

Statutory Instrument No. 100 of 2011: Provides for local authorities to manage solid waste in the areas of operation. Poorly managed solid waste systems lead to indiscriminate disposed of municipal waste into onsite sanitation facilities, making emptying services challenging.

4 Stakeholder Engagement

The consultant engaged stakeholders during collection of the data that was used to generate the SFD report. Stakeholders identified and engaged are presented in Appendices 1 and 2 in Section 7. For the purpose of the assignment, a focal point person was assigned from the utility who acted as the link between the consultant and the relevant stakeholders to be engaged. The focal point person attended a capacity building workshop to enhance his understanding on the development process of the SFD graphic and also to support the utility in identifying the data gaps and data needs to develop the SFD graphic.

The main engagement tools used by the consultant in data collection were Key Informant Interviews (KIIs) schedules and observation check-lists. The KII schedules consisted of a combination of structured and semi-structure questions designed to enable a full understanding and extract information on the operations and processes along the sanitation service chain. It was observed that most of the stakeholders have institutional memory on some of the sanitation systems. Therefore, the consultant also took advantage of this situation to dig deeper into the previous and current practices and systems.

The consultant was able to visit all the sites mentioned in this report and conducted detailed observations on the processes involved. Some of them were coupled with further discussions with stakeholders and operators and literature review.

5 Acknowledgements

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We would like to sincerely thank the GIZ Programme coordinating Team including Christian Rieck, David Mondorf and Mwaka Sikazwe. We would also like to convey our sincere gratitude to our partners from LgWSC including Mr. Phillip Zyambo, Mrs. Sharon Phiri, Mrs. Twambo, Mr. Tubber Maluma and Mr. Patrick Chipola. Lastly, we convey our gratitude to all those that assisted in one way on the other to the successful completion of this assignment.

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-10 KIIs conducted to several stakeholders during 2022 (Further information in Appendix 7).

7 Appendix

7.1 Appendix 1: Stakeholder identification

Stakeholder name	Designation	Contact number	Email
Mr. Njbele	Projects and Maintenance Manager	0977226975 0955835797	njebele@yahoo.co.uk
Mr. Nyonge Phiri	Director Engineer	0979281183	-
Mr. Thomas Samala	Sanitation Superintendent	0955271001	-
Mr. Daniel Kasase	Mulungushi Dam plant operator	0979576377	-
Mr. Moses Liemisa	Quality Assurance Officer	0955922717	-
Mr Chibuye	Mukobeko Well field and Treatment plant operator	0977616857	-
Mr. Philip Zyambo	Maintenance Engineer	0974369875 0954907681	zyambopr@gmail.com
Mrs. Sharon Phiri	Community Relations Officer	0977825395	bmsharon@yahoo.com
Mr. Shimpano Mutangama	NRW Coordinator/ Area Engineer Center	0979730255	smutangama@gmail.com
Mr. Patrick Chipola	GIS	0977718069	pchipola@yahoo.com

7.2 Appendix 2: Tracking of Stakeholder Engagement

No.	Stakeholder	Date(s) of engagement	Purpose of engagement
1	LgWSC	01.02.2022 to 13.02.22	1. KII - Data on on-site sanitation / information on on-going and planned projects in peri-urban areas in Lusaka 2. Operator interviews at the well fields and sewerage pump stations 3. Field visits to pump stations and wastewater stabilization ponds
2	LgWSC - GIS	02.02.2022	4. Sanitation maps available
3	LgWSC – Quality assurance	07.02.2022	5. KII on compliance

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