CASE STUDY OF WOBULENZI, UGANDA

I - GROUP ASSIGNMENT

Learning Objectives

The lectures explore ways to improve water supply, sanitation, and solid waste services to meet development goals for disease prevention, resource management, and environmental protection. In this case study, the students should critically discuss the content of the lectures with their colleagues and continuously integrate the newly acquired theoretical knowledge into a «real case». With this, the students should then be able to:

1. Apply course knowledge on water supply, sanitation, and solid waste to a real-world case study.
2. Analyse and prioritise case study information to identify key issues and challenges associated with water supply, sanitation, solid waste management and their interlinkages.
3. Develop contextually appropriate solutions to address the challenges presented from a real-world case study.

Overall assignment description

Context: Your group is a consortium of consultants with international experience, working jointly for the African Development Bank to engage with the Wobulenzi Town Council (WTC) to develop a short proposal on how to improve drinking water, sanitation, and solid waste services in the town. The Town Council and service providers will use your proposal to implement the technical and social interventions. The African Development Bank, using a grant from their trust fund, will fund the implementation. Your proposed solution must be as realistic as possible.

Assignment: Review the provided text and maps to identify the main challenges faced by the population, with respect to water, sanitation, and solid waste management and how they are interconnected. Present these challenges and propose solutions as if you were an external consultant hired by the African Development Bank. Focus on prioritising key interventions to address these issues effectively.

Detailed task description

Task 1: Water supply

Background: The main drinking water source in Wobulenzi is groundwater. Residents regularly switch to alternative water sources based on availability and cost, especially during the rainy months (March to May, and September to October) when many households harvest rainwater.

Need: The Town Council wants to provide enough water to the town to avoid water scarcity. Yet, the Town Council and the National Water & Sewerage Corporation (NWSC) have recognised that they will not be able to provide piped house connections to all. However, they expect to increase the number of house connections by 50% from the current level. The remaining coverage shall be met with public posts situated in urban neighbourhoods managed by NWSC and with new boreholes built in rural areas managed by District authorities and the Town Council.

Task: Propose a plan for improving the water supply services in WTC, taking into consideration issues of water quality, quantity, reliability, convenience and cost. Upgrades should consider the full water service chain: the source, intake, abstraction, treatment, distribution, and user point of consumption.

Specific sub-tasks:

1. Decide which technical approach should be employed for the design of a public water system (PSPs and piped water supply), covering treatment and distribution processes, including collection, transport, and storage.
2. Determine how these sites could be operated and managed to ensure sustainability.
3. Outline important aspects and criteria of water management that different parties must fulfil for sustainable functioning of the system.
4. Reflect on how seasonality (dry vs. rainy season) can affect the proposed solution in terms of sustainability.
5. Evaluate the feasibility of the proposed cost recovery approach and determine the pricing strategy for water sales to ensure operational cost recovery over time.
6. Propose solutions for balancing affordability and cost recovery to ensure equity.
7. Recommend promotional or educational activities aimed at raising awareness about clean water and justify your choices.
8. Place special considerations on factors that support the sustainability of the implemented solution.

Requirements:

- *Water Quality:* Drinking water must meet international safety standards (<1 CFU *E. coli* / 100 mL) at the point of collection and the point of consumption.
- *Quantity and reliability:* The proposed scheme should provide water services for at least 12 hours per day on a predictable schedule across all seasons. Consider using storage solutions to enhance the reliability of water services and to meet a minimum threshold of 50 litres per capita per day (LPCD).
- *Delivery solutions:* These can include measures for safely transporting and storing water at household level, including avoiding re-contamination, which has emerged to be a priority.
- *Convenience and cost:* The Ministry of Water and Environment, through its Water and Sanitation Development Facility, will cover the upfront capital costs of hardware, i.e. water scheme upgrades and installations. Ongoing operation, maintenance and repair costs must be fully recovered by NWSC for piped water and water user committees for boreholes through the sale of water to consumers (subsidies are possible). User fees should not exceed 5% of households' monthly income (or one day's worth of labour at minimum wage).
- Equity, gender, and discrimination: Serving the poorest customers will require affordable solutions for delivering water services to the far outskirts of the town. Consider also that women and girls are most often responsible for fetching water, and that people living with disabilities may require special accommodations to access public water points.

TASK 2: Sanitation

Background: Because the population is increasing, pits cannot be abandoned anymore, and regular emptying will become a necessity.

Need: The NWSC wants to improve the faecal sludge management system so that sludge emptying can be provided (at a cost) for all those with pit latrines and septic tanks when required. The initial priority is to ensure that all newly built pits are properly lined to prevent groundwater contamination and make it possible to empty the pits. Simultaneously, the corporation intends to use the existing sludge treatment facility at full capacity, which is currently underutilised. For greywater from

households with pits, the NWSC wants to phase out “discharge into drains” as the drains flow directly into nearby ponds and wetlands. Furthermore, they want to terminate open defecation and provide those without toilets with a feasible sanitation solution.

Task: *Propose a sanitation solution across the sanitation service chain, including a resource recovery option for the project area.* This must be done while addressing financial constraints and raising community awareness.

Specific sub-tasks:

1. Suggest a faecal sludge collection and transport solution in terms of technical specifications and discuss operational and management requirements for your solution. The existing truck must also serve other towns in the four nearby districts.
2. Implement a transition process to ensure that all newly built latrines are adequately lined for efficient emptying. Assume the provision of (partial) government subsidies.
3. Assuming there will be increasing volumes delivered to the faecal sludge treatment plant, explore the optimal resource recovery options for the town and justify their selection.
4. Explore strategies to enhance the affordability of desludging services from a collection point of view. Detailed cost calculations are unnecessary, only the household payment amount and potential subsidies need to be considered.
5. Propose a greywater management system, investigating recycling solutions for sustainable water reuse.
6. Illustrate your “complete” solution by producing one or multiple system templates, using the system drawing too. Your system templates should show your technological choices, the related sanitation products, and the different flows. Justify all your decisions.

Additional information:

Table 1 helps estimate the sludge generation from the households.

Table 1: Estimate of faecal sludge generation. Adapted from CSE. 2017

	Based on USEPA manual	Based on the IS code
Faecal sludge generation	230 litres per year per capita	120 litres per year per capita
Average Household size	5	5
Faecal sludge generation per household	1’150 litres or 1.15 cum per year	600 litres or 0.6 cum per year

In general, the capacity of pit latrines containments ranges from 7–18 m^3 for households; 10–25 m^3 for community or public toilets. You can assume that household sanitation facilities should be emptied once every five years. For further information on sludge properties and characteristics, see: https://www.eawag.ch/fileadmin/Domain1/Abteilungen/sandec/publikationen/EWM/FS_Methods_Book/Ch02.pdf

TASK 3: Solid Waste

Background: Waste collection is not assured to enough households and the dumpsites are uncontrolled as waste is openly dumped and the sites are often burning.

Need: The Town council is committed to improve the waste collection services and coverage and enhance a circular economy by improved recovery of recyclables with a new truck. Furthermore, their intention is to recover recyclable materials from the landfill.

Task: Develop a business and operational plan for small enterprises to operate a waste collection service in this town and develop an implementation plan to upgrade the disposal site and its operation. All assumptions should be convincingly explained.

Specific sub-tasks:

1. Suggest how the waste collection service by the Town Council could be improved and strengthened.
2. Describe all the components (infrastructure/equipment, labour, and frequency of collection) and the financial aspect that would be needed to provide an adequate and sustainable waste collection service.
3. Suggest how the informal sector involved in the collection of recyclables can be more effectively integrated and involved in the overall waste management process.
4. Assess the feasibility of outsourcing recycling operations to private companies and expertise and address the challenges.
5. Explore better integrating composting to improve overall waste management. All assumptions should be convincingly explained.

TASK 4: Interlinkages and critical reflection

Task: After proposing solutions (in Tasks 1-3) for improving water, sanitation, and solid waste infrastructure and services in your project area, think critically about how sectoral solutions address the interlinkages and the challenges and limitations of the proposed solutions. Additionally reflect on issues of social equity, gender, and discrimination.

Specific sub-tasks:

1. Discuss the possibility of integrating these solutions. Describe the opportunities (e.g. synergies) of an integrated approach in this case.
2. Identify the greatest challenges and risks of an integrated approach and explain their significance, including the aspects of equity.
3. Assume there are additional funds for a detailed planning process for six months and list the steps that you would subsequently take to make an integrated plan.

Expected assignment output.

Five exercise tasks need to be fulfilled in groups of four-five students throughout the lectures. All task results must be documented in one report (max. 13 pages, Arial 10). The structure of the report is presented in Table 2.

Table 2: Final report content

	Content	*Max. pages*
Title page	Name, email and student number of all group members	1
Water	Description, visualisation of the results and discussion	3
Sanitation	Description, visualisation of the results and discussion	3
Solid waste	Description, visualisation of the results and discussion	3
Integration	Description of the integration opportunities, and critical reflection on the proposed solutions	3

If required, annexes are allowed, but these should only consist of figures, graphs, or tables.

Grading Criteria

The report accounts for 30% of the final grade. For each task, (1-4), the grading will follow the criteria presented in Table 3, and the overall grade will be an average of the four tasks.

Table 3: Grading matrix criteria

Criteria	**Insufficient <4**	**Sufficient 4**	**Good 5**	**Very Good 6**
Content Fulfilment	Weak arguments, superficial application of theories.	Convincing arguments with realistic values/assumptions and thorough application of theories.	Strong arguments, realistic values/assumptions, and comprehensive application of theories.	Compelling arguments, realistic values/assumptions, comprehensive application of theories, and consideration of additional limitations or theoretical depth.
Discussion and contextual understanding	Superficial discussion lacks depth and insight.	Adequate depth in discussion, offers additional insights based on provided data.	Good depth in discussion, providing insightful analysis. Discussion of non-technical issues and the enabling environment.	Very good depth of discussion, offering insightful analysis. Discussion of non-technical issues, and consideration of relevant external factors, such as sustainability factors.
Writing style and appeal.	Unclear language and writing style with factual, logical, and grammatical errors.	Fair language and clear writing style that is considerate of readers.	Clear and engaging language.	Clear, precise, and engaging language with persuasive arguments
Structure and layout	Unclear structure, no logical flow.	Good structure and layout, logical and coherent flow of information. Has all required elements, but exceeds page limits.	Organised structure with coherent flow and adequate visualisation. Appropriate length but lacks prioritisation of information.	Well-organised structure with logical flow and effective visualisation. Optimal length, providing necessary detail without being overly verbose. Prioritises the tasks adequately.

II - GENERAL INFORMATION ABOUT THE TOWN

Geographical profile and landscape

Located in East Africa, Uganda has a population of approximately 49.6 million people, with Kampala as its capital. Currently, 26 % of Ugandans reside in urban areas, and there is presently development of several small towns across the country. Among these emerging towns is Wobulenzi, a Town Council located 47 kilometres north of Kampala along the Kampala–Gulu Highway in Luwero District. The town covers an area of 17.3 km^2 and has an average altitude of 1'107 metres above sea level.

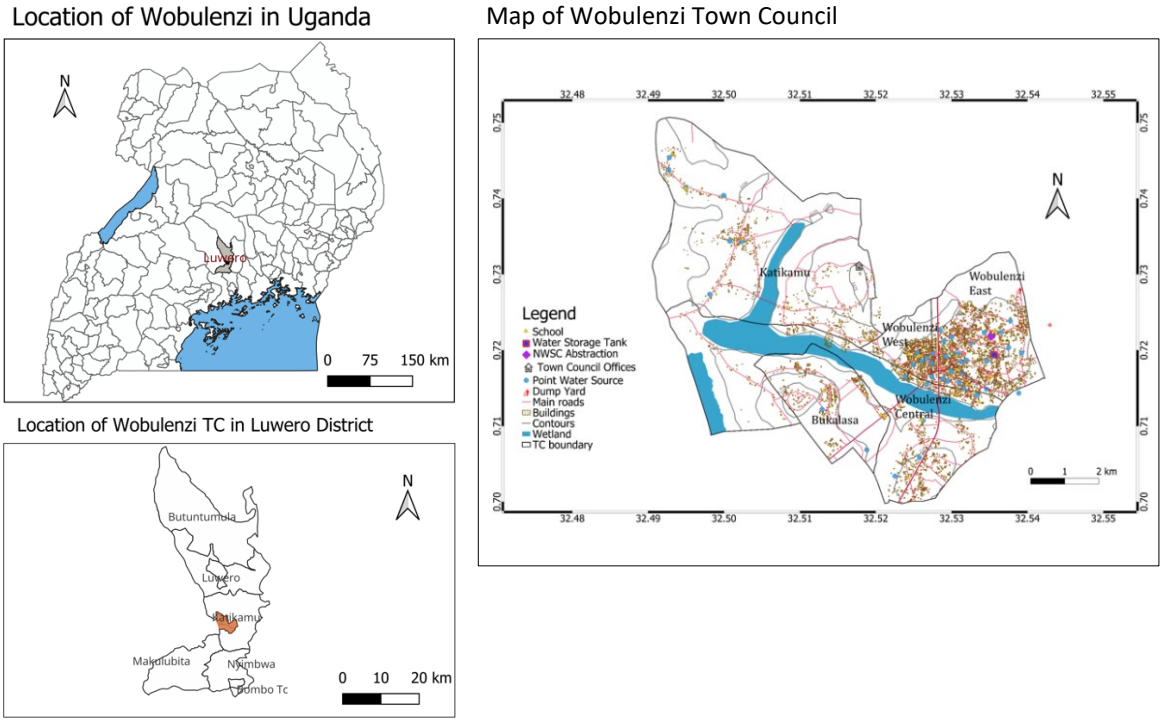

Figure 1: Location of Luwero district in Uganda (top left), location of Wobulenzi Town Council in Luwero district (bottom left) and map of Wobulenzi Town Council (right)

Wobulenzi experiences a tropical rainforest climate. It maintains a yearly temperature of 26.1 ºC, which is 2.63% higher than Uganda's average. The region receives an annual precipitation of about 169.73 mm over 272 rainy days, accounting for 74.53 % of the time. The warmest month is February with a temperature of 36.3 ºC, while the coldest month is June with 16.92 ºC. October is the wettest month with 271.05 mm of rainfall. The dry season lasts from December to February, and January is the driest month with 47.28 mm of rainfall.

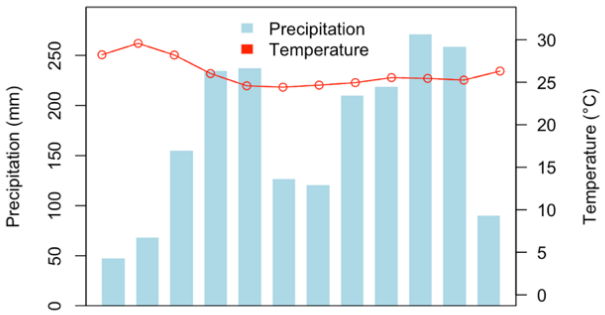

Figure 2: Mean temperature and precipitation in Wobulenzi in 2017.

Socio-demographic and socio-economic profile

According to the town's five-year development plans, Wobulenzi's population was projected to be 36'031 by 2023. The average household size is currently five persons. 328 households were surveyed, representing 1'739 individuals, with

approximately 22.3% being children under the age of five. Among the surveyed population, 48.5% are women or girls. In total, 57.62% live in urban areas, 15.85% live in rural areas and 26.52% in peri-urban areas. The definitions of these settlement areas are provided in Appendix A.2.

Regarding the educational attainment within households, the highest level of education achieved by men typically ranges from secondary school (38.4%) to primary school (35.9%), with only 19.4% possessing a higher degree or diploma. The remaining individuals in this category have had no formal schooling. In terms of the educational levels of women within households, 45.8% have attained at most primary school education, followed closely by secondary school at 38.6%. A smaller percentage, approximately 8.1%, have obtained a higher degree certificate, while the rest have had no formal schooling.

The primary economic activity of adults in households is agriculture, which accounts for 39.9% of total economic activity, followed by small business at 31.9%. Other activities include government service, daily work, and various forms of self-employment, albeit in smaller proportions. Figure 3 gives the overview of all activities. The town's economic landscape is diverse, with the majority (75%) spending between 50’000 to 500’000 UGX per month. More details are shown in Figure 4.

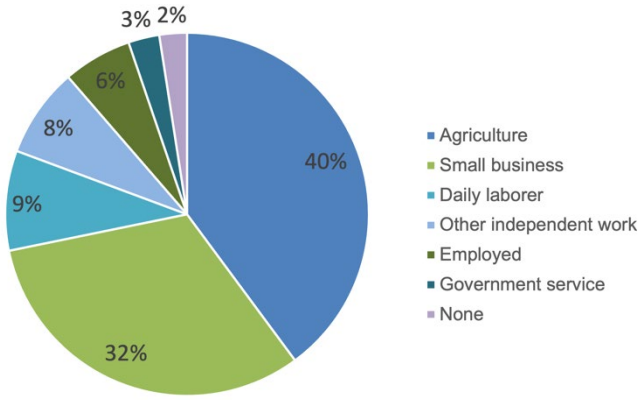

Figure 3: Main activity of households

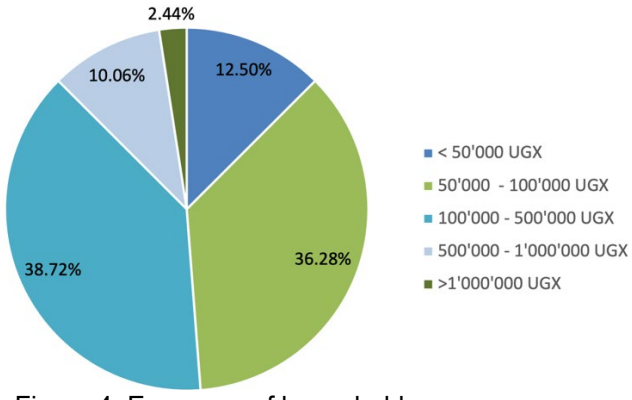

Figure 4: Expenses of households

Cultural practices

Situated within the territory of the Buganda Kingdom, WTC is characterised by its rich cultural heritage and warm, welcoming inhabitants who communicate primarily in the Luganda language. Although it lacks historical landmarks, its association with the famous "Luweero Triangle" gives it historical significance in Uganda's history. This area played a pivotal role in the resistance to the government of Milton Obote during the tumultuous 1980s, serving as a strategic base for the National Resistance Army (NRA) under the leadership of Yoweri Museveni, who later ascended to the presidency.

Religiously diverse, the community is predominantly Christian and Muslim, with smaller religious groups making up the remaining percentage. Despite these religious differences, harmony prevails within the community, with interfaith relations characterised by mutual respect and peaceful coexistence, fostering a united and cohesive community fabric.

Political / Institutional landscape

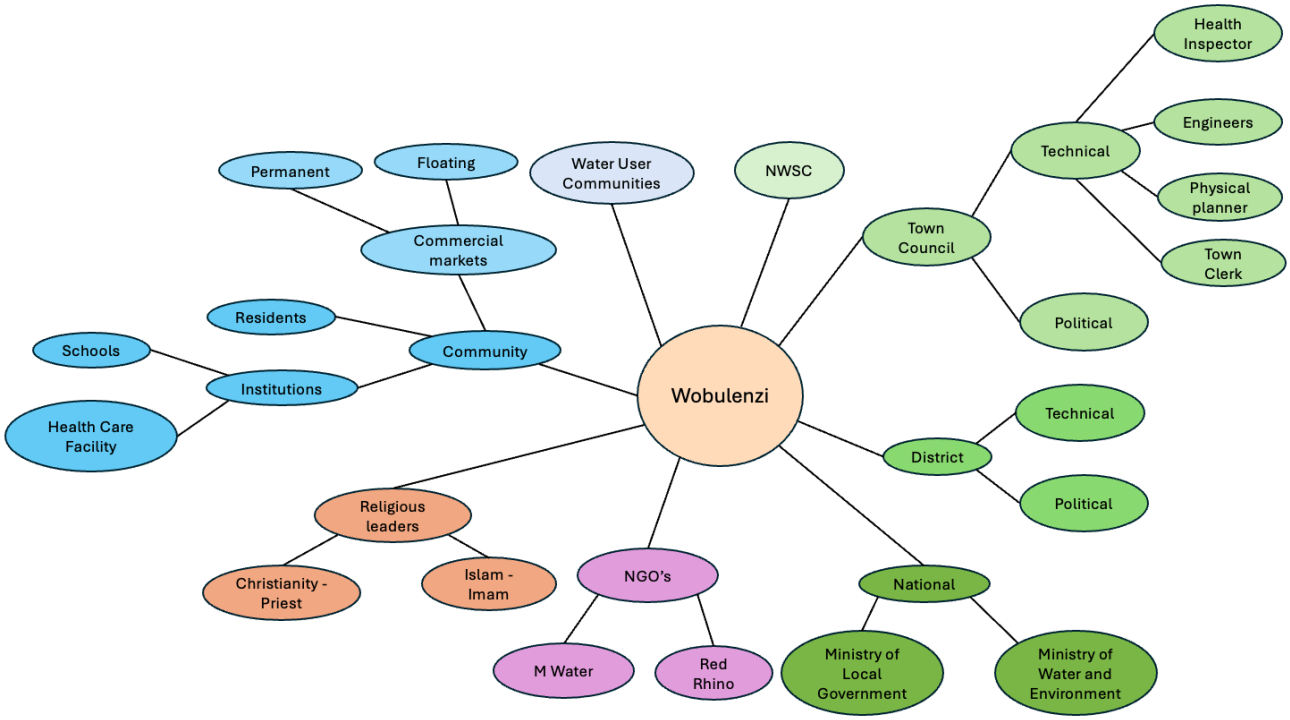

Figure 5: Classification of Stakeholders in Wobulenzi

The country's government is organised by various ministries, including the Ministry for Local Government that oversees various districts. Local government levels are as follows (Figure 5):

- Village (LC1): The lowest level, consisting of 50-70 households and 250-1,000 people. Governed by a LC1 Chairman and nine executive committee members.
- Parish (LC2): Made up of several villages, with a LC2 committee of all the LC1 Chairmen. Largely run by a Parish Chief.
- **Sub-County / Town Council (LC3): Consists of several parishes, with an elected LC3 Chairperson, executive committee, and council. In urban areas, this is called a Town Council (TC).**
- County (LC4): Several sub-counties make up a county, represented by an elected Member of Parliament (MP) in the national parliament.
- District (LC5): The highest local government level, consisting of multiple counties and municipalities. Led by an elected LC5 Chairperson, executive, and council.

A Town Council is divided into two parts: a political side, led by a mayor and councillors, and a technical side managed by a town clerk and their technical staff. The technical side includes different departments, such as public health, finance, commerce, industry, community services, and production. A detailed organogram of the town council is provided in Appendix A.3.

There is a constant back and forth between the two parts of the town council – the technical and political. Both are also concerned about the overreach of the other. This has led to slightly strained relations between the two. In many instances, the elected officials have told residents in their constituency to undermine the rules set by the Town Council overall, such as the payment for garbage collection and disposal.

Much of the Town's development plan has been influenced by reports and standards provided by the national government, such as the Parish Model, or the National Development Plan – III, which the country is largely aligned with.

Regulatory framework

Urban water and sanitation responsibilities are shared between the National Water & Sewerage Corporation (NWSC) and WTC.

The NSWC provides the water supply in the towns with piped water. Yet, it serves only 22.6% of the households privately. The rest of the households receive water from borewells, especially in rural areas, which are directly managed by the district government. The role of the Town Council has been minimised in recent years. Among the Town Council members, there remains a sense of dissatisfaction due to these changes.

There is no centralised sewer system. NWSC operates and maintains a faecal sludge treatment plant (FSTP). Sanitation and hygiene are under the purview of the health inspector from a household perspective. Treatment is under the purview of NWSC, but due to the low demand for emptying services, the FSTP is only partially functional and there is no emptying truck stationed in Wobulenzi. Therefore, where available, the private sector provides emptying services.

Solid waste services are provided by the Town Council. Waste collection is outsourced to a private company, which is owned by the political members of the Town Council. This sometimes leads to conflicts of interest.

Infrastructure and housing

Figure 6: Two types of housing in Wobulenzi

Housing in Wobulenzi ranges from traditional to more modern structures, as represented in Figure 6. Traditional homes are often made of locally sourced materials such as mud bricks, and thatched or corrugated iron sheets for roofing. These traditional houses tend to have a simple design and may lack amenities, such as running water and electricity. In contrast, modern housing in Wobulenzi may consist of concrete or brick structures with tiled or iron sheet roofs. These houses often have better amenities and may be equipped with electricity, running water, and sanitation facilities.

Water Supply

System description

In Wobulenzi, water is supplied either through piped systems (cf. Figure 7) or directly from boreholes (cf. Figure 8). The NWSC manages the piped water supply system, which consists of two systems:

A) The first system draws groundwater from three boreholes, with two operational at the time of inspection, yielding 9 and 3 m^3/h respectively. This groundwater is channelled into a 50 m^3 tank for chlorination that is achieved by continuously introducing a chlorine solution into the water (5.2 grams per litre of powdered chlorine mixed with water). The chlorinated water is subsequently pumped into an elevated storage tank with a capacity of 250 m^3.
B) The second system complements the water supply by piping water from Luwero overnight. Groundwater extracted in Luwero at a rate of 72 m^3/h is pumped into two elevated storage tanks, each with a capacity of 150 m^3. Chlorination of this water occurs within the storage tanks through the continuous addition of a chlorine solution.

The treated water is then distributed to approximately 2'000 private in-yard connections and 140 public standpipes. To mitigate challenges associated with fluctuating water inflow, plans are underway to construct a storage tank in Wobulenzi for storing water from Luwero during nighttime hours. In addition to these systems, the District Water Officer oversees 1'000 boreholes in Luwero District to cater to the community's needs. Each borehole is associated with a Water Users Committee (WUC), responsible for fundraising for repair and maintenance. These committees collect monthly contributions from users, which are utilised to compensate a private contractor (Busoga Trust, NGO) for repairs. However, due to limited funds, only around 10 repairs are conducted annually. Furthermore, a larger borehole within the town supplies a public standpipe, generating sales of 600 jerrycans per day at a rate of 100 Ugandan Shillings (UGX) per jerrycan (approx. 20 Litres). Originally constructed by Indians in the 1970s, this system is currently owned and managed by a local councillor.

Table 4: NWSC tariffs for private and PSP connections

	NWSC price per m^3	**Customer price per m^3**
Private connections	4'224	-
Public standpipes (PSP)	1'060	5'000-15'000

For the PSP, the small-scale operators buy water from the NWSC at a price of 1'060 UGX /m^3 and sell it to customers at 100-300 UGX/jerrycan (UGX 5'000-15'000/m^3). For more details, a Water Flow Diagram is provided in Appendix A.4.

Figure 7: Public stand pipes with taps

Figure 8: Water from a borehole with a pump

Water access

Access to formal water services varies, with 44.2% of the households using piped water as their main drinking water source, specifically 22.6% having yard connections and 21.6% using public standpipes (cf. Figure 9). Improved sources are sources protected from their environment, such as protected dug wells or protected springs. Unimproved sources are sources not protected from their environment, such as unprotected dug wells or unprotected springs.

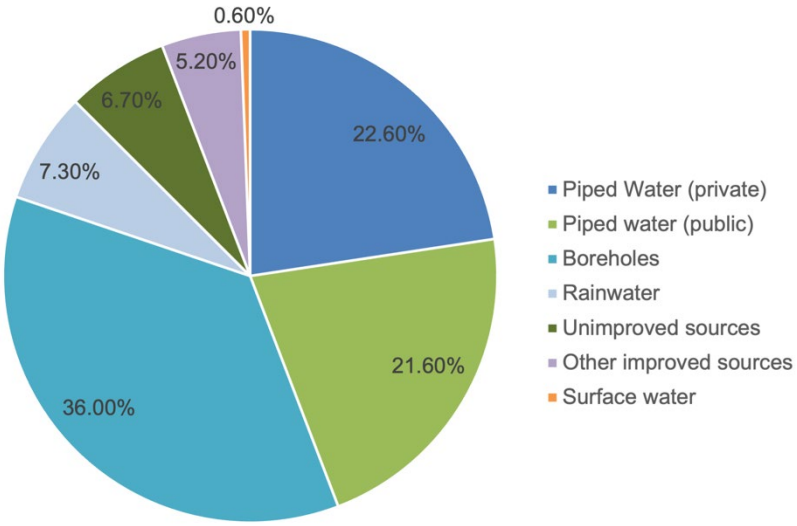

Figure 9: Repartition of water source.

Urban areas predominantly rely on piped water (61%), while rural and peri-urban areas mostly use boreholes, 50% and 51.7%, respectively. Many households (72%) switch between water sources throughout the year due to intermittency (38%), availability (34%), breakdowns (33%), or payment burdens (16%). Although most respondents report consistent availability from their main water source, interruptions are common, particularly for piped water users.

Table 5: Information on water availability

	Piped water (private)	**Piped water (public)**	**Borehole**	**Other sources**
Water always available	51%	48%	64%	72%
Median fetching time	2 min	5 min	10 min	5 min
Mean interruptions	2.3 days/month	2.2 days/month	0.8 days/month	1.0 days/month
Interrupted at least once	48.6 %	47.9 %	40.7 %	26.2 %

Figure 10 shows that the water storage tank and primary water supply points are located in Wobulenzi East and Wobulenzi West, catering to the majority of the resident population. However, the Katikamu Ward faces a scarcity of water sources. The central areas are then better served in terms of WASH infrastructure. More details about the spatial distribution of water supply service levels in Wobulenzi are provided in Appendix A.5.

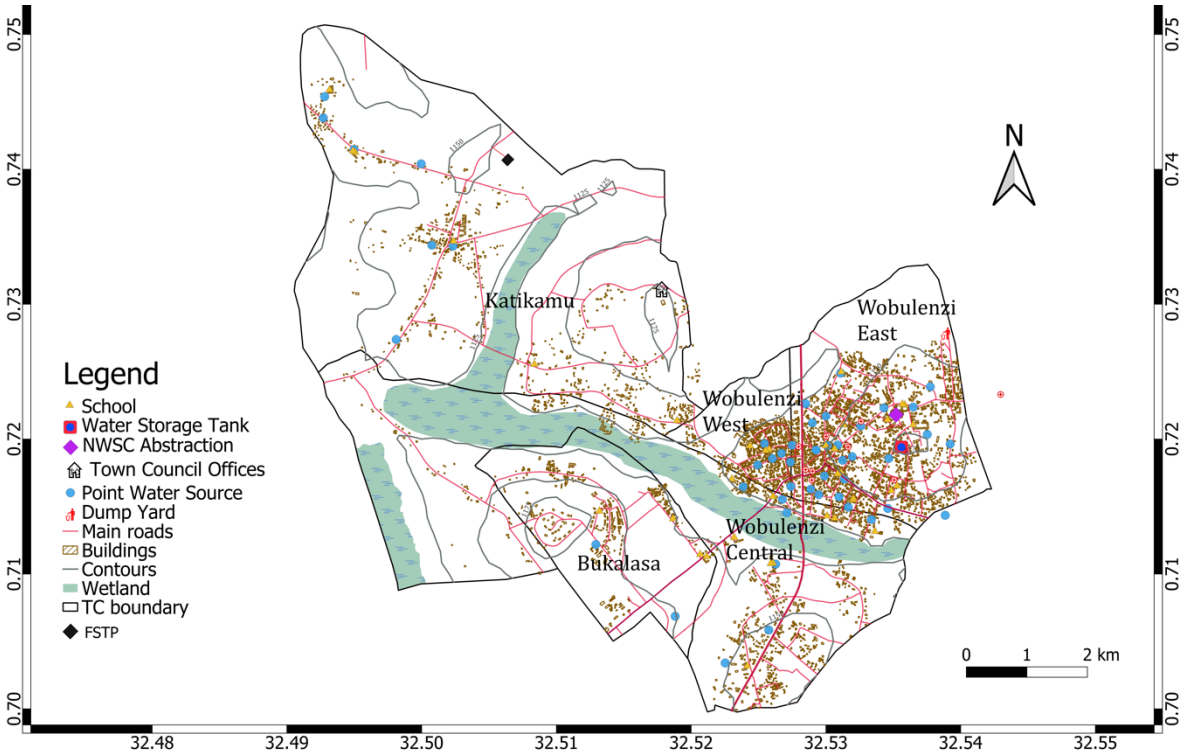

Figure 10: WASH features and urbanised area of Wolubenzi Town Council

Water Quality

The water quality analysis of the piped water system is conducted monthly by the NWSC at the source, i.e. three wells, the storage tank, and various distribution taps. The parameters examined are pH, alkalinity, hardness, electrical conductivity, total suspended solids, turbidity, colour, free chlorine, total chlorine, E. coli, and iron. Boreholes monitoring, limited to 100-175 assessments per year, focuses on functionality, yield, pH, E. coli, and total coliform. The overall results of these analyses are satisfactory. For instance, fluoride and heavy metal levels in both the piped water supply and other groundwater sources are well below the WHO's maximum permissible limit, while elevated levels of iron were detected in two samples from the piped water supply and two from other groundwater sources, possibly due to pipe corrosion.

However, analysis of the presence of E. coli at the household level in different storage containers reveals a concerning level of contamination.

Table 6: Presence of E.coli at the household level

E. Coli test	Clay pot	Jerrycan	Other
Absence	24%	18%	42%
Presence	76%	82%	58%

Furthermore, a refined in-depth analysis reveals a troubling trend of recontamination occurring between the water source and consumption points, despite boiling and storage. This recontamination was observed in 45% of the cases, while 18% of the households showed no change in E. coli levels and 36% showed a reduction. According to WHO guidelines, pH and turbidity at the point of consumption were within acceptable ranges in this in-depth analysis. However, only two of the seven piped water taps had detectable residual chlorine, indicating unsatisfactory disinfection levels.

JMP ladder

Half of the households had basic drinking water services, according to the JMP ladder classification provided in Figure 11. Definitions of each step of the drinking water service ladder are provided in the Appendix A.6.

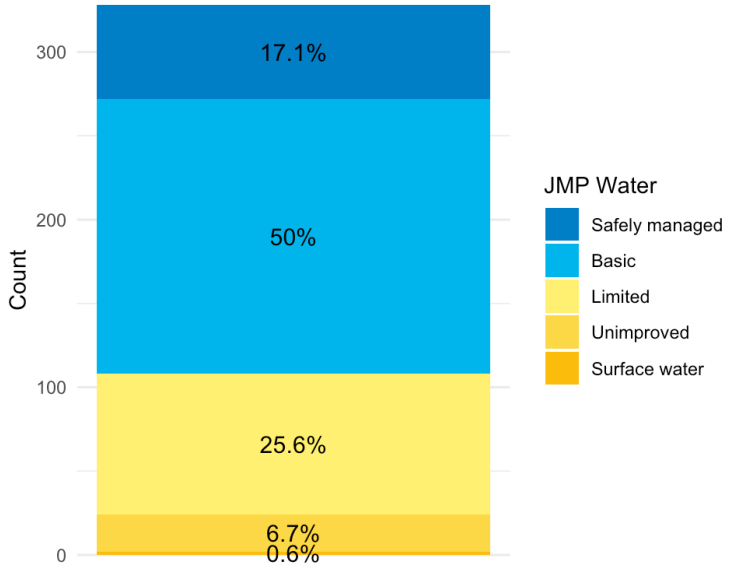

Figure 11: JMP Ladder for Water in Wobulenzi

Satisfaction

Overall, 79% of the households reported being satisfied or very satisfied with their water sources. Most users considered boreholes and public-piped water supply to be safe (90%), while only 70% of the users of private piped connections or other sources shared this perception. The water taste was generally perceived as good (80%), although private piped connection users were less satisfied (only 60%), with some complaining about the taste of chlorine.

Table 7: The households' monthly water expenses and willingness to pay for water services

	Monthly water expenses	**Willingness to pay**
0 - 5'000 UGX	36%	41%
5'000 - 15'000 UGX	32%	36%
15'000 - 30'000 UGX	15%	16%
> 30'000 UGX	16%	6%

On average, households spent 11'200 UGX per month on water services, which is 8% of their monthly income. The average willingness to pay (WTP) was 8'300 UGX per month, lower than the actual expenses.

Challenges

- Intermittent water supply
- **Inadequate chlorine dosing**, which leads to absence of chlorine at tap level and E. coli contamination

- **Dirty and inadequately kept storage containers** in the household that lead to recontamination of drinking water, even after the water has been boiled.
- Complaints about **chlorine/chemical taste** of the water from the piped water supply system, and overall lack of awareness among the people about the benefits of chlorine treatment
- **Low WTP** to pay for piped water supply.

Sanitation

System description

Sanitation management in Wobulenzi is coordinated by the Town Council. There is neither a sewerage network, nor a centralised sewage treatment plant. Wobulenzi relies entirely on on-site sanitation solutions that require FSM services. There are currently no vacuum trucks in Wobulenzi, but there is a truck available on call from another district. It is a mechanical vacuum truck, which has a capacity of 8 m^3 to collect faecal sludge. More information on the FSTP and its operation is provided in Appendix A.7. At present, FSM services, such as emptying, are mostly unregulated, but WTC has recently been encouraging pit emptiers to use the FSTP rather than dumping faecal sludge in the river or drains. It is also difficult to attract qualified staff, given a lack of career opportunities and low pay.

The predominant sanitation facilities used by the population are pit latrines, either individually owned or shared among households. Specifically, 69.5% of the households have private latrines, while 29.5% use shared household latrines. Only a small fraction of the households, 0.3 % (corresponding to one person), utilize public facilities, and 0.7% (corresponding to two persons) reported having no toilet onsite, resorting to alternatives, such as using neighbours' facilities or practicing open defecation. Even if the people in the households (except one person) do not practice open defecation, some people coming to the markets do.

Regarding toilet types, 96.4% of the respondents use drop hole latrines, while only 0.6% use cistern flush toilets and 2.4% use pour-flush toilets. In terms of containment types, Figure 12 shows that most containments are unlined pit latrines that cannot be formally emptied. Currently, when a pit is full, a new one is constructed. An alternative practice is to wait for a rainy event and open the pit during that time, allowing the waste to be washed away or emptied naturally by the rainwater. For more details, an Excreta Flow Diagram is provided in Appendix A.4.

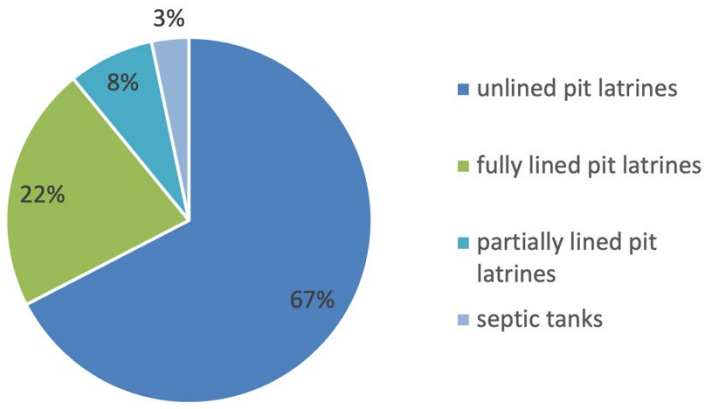

Figure 12: Containment types with detailed type of latrines.

Access to formal services

In Wobulenzi, access to toilets is high, with only 0.7% (three people) not having access, resorting to open defecation or using facilities in the neighbourhood. Emptying services are severely limited, with only 3% of the households reporting having their latrine emptied, with an average interval of one year between emptying. Emptying is currently conducted by private emptiers. The type of toilets among the households varies among different settlement types. In urban areas, 60.8% of the households have private latrines, while 38.6% rely on shared facilities. In contrast, the prevalence of private toilets in peri-urban and rural areas substantially increases to 88.5% and 86.3%, respectively. The repartition of containment types also varies among settlement types. Table 8 shows that fully lined pit latrines are less prevalent in rural areas, compared to urban and peri-urban areas. Figure 13 illustrates an example of a pit latrine in a rural area.

Table 8: Repartition of type of toilets in each area (urban, peri-urban and rural)

	Fully lined pit latrine	**Partially lined pit latrine**	**Unlined pit latrine**	**Septic tank**
	%	**%**	**%**	**%**
Urban	22.3	2.4	69.9	5.4
Peri-Urban	26.1	15.9	56.8	1.1
Rural	12	10	78	0

Regarding hygiene, hand-washing facilities are lacking for 53% of the households, although where they are available, they are mostly functional (96.5%). Overall, soap was consistently available in 23.2% of the households and only intermittently in 3.7%, while the majority (73.1%) had no access to soap. More details about spatial distribution of sanitations and hygiene service levels in Wobulenzi are provided in Appendix A.5.

Quality

Roughly, two-thirds of the latrine facilities have been classified as either clean or very clean. A clean facility indicates the absence of litter on the floor and no faeces in the vicinity. Meanwhile, a facility deemed very clean has not only cleared these criteria, but also has its floor meticulously wiped, as illustrated in Figure 14. Conversely, the remaining one-third falls into the categories of fairly clean or not clean. In the fairly clean category, only minor debris, such as paper or dust was observed, while the designation of not clean indicates the presence of faeces.

Figure 13: Unfinished pit latrine

Figure 14: Very clean pit latrine

JMP ladder

Sanitation systems are considered safely managed if they are private and if the excreta are safely disposed of. Because the containments in the WTC are rarely emptied, a large proportion of the systems, 61.8%, are considered to be safely managed systems (cf. Figure 15). However, they may not be considered safely managed in the future when the pits become full, and the construction of new unlined pits is no longer sustainable. In addition, a significant proportion, around 29.4%, of sanitation services fall into the category of limited services, consisting mainly of shared facilities. The definitions of each step of the sanitation service ladder are provided in the Appendix A.6.

Figure 15: JMP ladders for sanitation (left) and hygiene (right) in Wobulenzi

Satisfaction

The perceptions and satisfaction among the population regarding the sanitation and hygiene facilities in Wobulenzi show that the majority is satisfied, with 16.5% very satisfied and 57.0% satisfied. People expressing dissatisfaction to very dissatisfaction, constituting 7.3%, use drop-hole interfaces and facilities that accommodate a large number of users.

Additionally, people generally reported to be willing to pay for emptying services and mentioned values of 20'000-100'000 for more frequent emptying (every three-five years), and 200'000 UGX, 300'000 UGX, 500'000 UGX for longer emptying intervals (10-15 years).

Challenges

- Lack of (lined) pit **latrines that can be emptied**.
- **Availability** of an emptying truck.
- **Financing** for emptying activities.

Solid Waste Management

System description

The waste management system depends on both informal and formal processes. The formal processes are the responsibility of the Town Council, while informal activities focus predominantly on the recycling sector.

Formal waste collection is carried out by the Town Council, using an existing truck. Staff of the formal collection service separate PET bottles and cardboard from the waste during collection, which are then sold to scrap buyers at the end of their shift. The remaining mixed waste is transported and mainly disposed of at three uncontrolled dumpsites, with only one being within the boundaries of WTC (cf. Figure 10). The distance from the dumpsite and the season of year determines which dumpsite is selected for use – as one site is less accessible during the rainy season. The dumpsites are uncontrolled, waste is openly dumped and the sites are often burning. Regarding formal recycling, there is a formal take-back system for glass in bars, restaurants and shops at the national level, which is also implemented here. Businesses that sell glass bottles must return the empty bottles to receive new full bottles. At the factories, the bottles are cleaned and reused up to five times.

Informally, recyclables are collected by junk buyers who traverse the town area on motorbikes, purchasing items like PET and PE bags, metals, and aluminium pans from households and businesses. These recyclables are then sold to small junk shops, which in turn sell them to larger dealers that transport them by truck to recycling companies in Kampala. This informal sector is viewed positively within the community due to its transparency and contribution to waste management. For more details, solid waste diagrams for all generated waste and for plastics are provided in Appendix A.4.

Access to services

Formal daily waste collection takes place only if garbage bags or containers are available, and moved to the curb-side the day of waste collection. However, 54.9% of the households do not have waste containers. Those households with containers use either metal or plastic containers (18.0%), cardboard baskets (7.6%), or sacks (18.9%). In total, about 34.4% of households report having their

waste collected by the municipality. The majority of households (89%) do not pay for waste collection, but those that do pay have fees ranging from UGX 1’500 to UGX 10’000 per month.

Waste segregation behaviour at the household level

The waste management behaviour of the surveyed households indicates significant participation in waste separation and recycling activities.

Table 9: Level of segregation of kitchen waste, garden waste and recyclables

Level	Kitchen waste	Garden waste	Recyclables
Percent of households segregating [%]	61.3	53.4	69.8

The primary purposes for segregating kitchen waste include feeding animals, composting, or providing it to farmers. Among those who segregate kitchen waste, 44% choose to store it on their property until use or provision to farmers. A smaller percentage provide the segregated kitchen waste to others by disposing it in front of their houses (8%) or taking it to collection points (15%). The remaining households burn or dump their segregated kitchen waste.

Table 10: Level of segregation of various recyclables

Recyclable	% of segregation
PET	77%
Soft plastics	69%
hard plastics	47%
Metal	35%
Paper	38%
Glass	31%
E-device	26%
Cardboard	24%
None	17%

Regarding the disposal of segregated garden waste, almost half of the households (45%) keep it on their property, while others bring it to collection points (11%). Composting is the most common treatment of segregated garden waste (44%), followed by using the waste as animal feed (14%). For 4% of the households, the garden waste is collected by farms for free.

In terms of segregated recyclables, PET is the most separated material, with 77% of the households practicing this behaviour. 17% of the households do not separate any recyclables.

A significant percentage of households (40%) choose to burn the segregated recyclables. Others prefer to sell (26%) or donate (14%) recyclable materials to the informal sector.

General waste disposal

Concerning household waste disposal, 42% of the households in Wobulenzi claim to never dispose of waste in inappropriate areas, while 25% do so infrequently. The remaining 33% dump waste with varying frequency, ranging from daily to every few days.

In terms of waste burning, 30% of the households never engage in this practice, while 27% do so rarely. About 22% burn waste once a week, with the rest doing so more frequently.

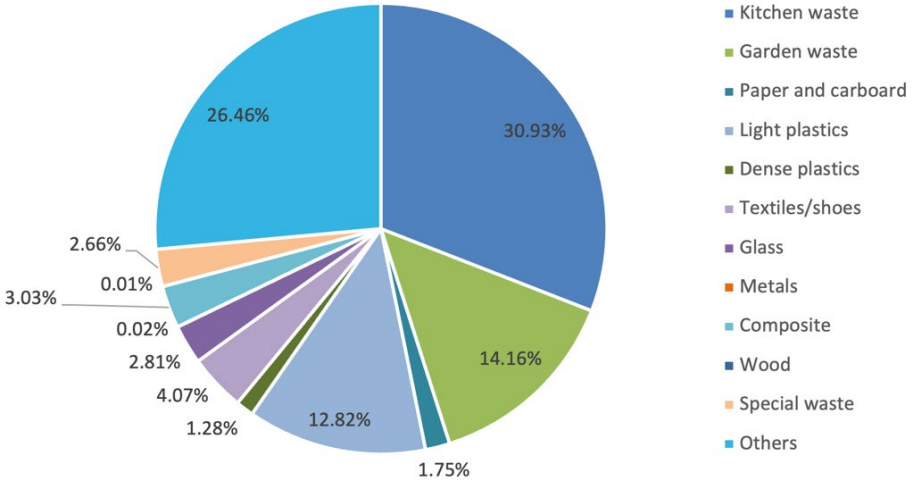

Figure 15: Landfill waste composition

In terms of dumpsite operations at the landfills, the largest waste fraction collected is kitchen waste, 31%. The category “others” is mainly dirt and ashes.

Satisfaction

Most households (51%) express being "Not at all satisfied" with waste management, while smaller percentages indicate moderate (31%) to higher levels of satisfaction (19%).

Challenges

- Collection workers paid irregularly.
- Collection trucks in bad conditions.
- Extensive open burning. People want “waste gone”.
- Segregation depends on waste type, nevertheless burning does occur.
- Motivation to segregate waste highly depends on its use. Many report that they would segregate more if they had a use for it (e.g. owning animals).

Interlinkages

Negative interlinkages

- Approximately 60.7% of the households inappropriately dispose of solid waste by putting it into toilets or by throwing it in pits far from their homes, creating solid waste in containments.
- The interaction of animals with sanitation facilities and water storage containers poses a risk of contamination, as animals in yards can potentially contaminate water sources or storage containers. Animals have been observed grazing in landfills, increasing the risk of contamination.
- Leaks from sanitation containers into groundwater sources introduce faecal bacteria into drinking water, particularly from unlined pit latrines.
- Young children can contaminate water storage containers with E. coli due to poor hygiene practices. In general, poor hygiene practices contribute to the contamination of drinking water, as evidenced by the higher presence of E. coli in households without handwashing facilities.
- Direct dumping of sanitation waste into water sources during rain events exacerbates pollution. Sometimes, pit emptiers dump faecal waste into swamps and barren land during such events.
- Storm drains also face solid waste pollution, with 7.3% of the households dumping solid waste into the storm drains in front of their homes. During the transect walks, it was observed that the storm drains were filled with mixed waste (organic and plastic). These drains lead to swamps and wetlands along the highways, further degrading them.
- Solid waste leachate from landfills have contaminated nearby water sources. Although there is limited evidence in the grab samples of elevated concentrations of various pollutants in ponds near the Wobulenzi landfill, nearby residents have reported foul-smelling water from the groundwater sources.

Figure 16: Animal grazing at a landfill

Figure 17: Rainwater drainage with waste

Positive interlinkages

- A majority (74%) of respondents reuse greywater, mainly for cleaning (58%), toilet flushing (23%), garden irrigation (21%) and animal feeding (3%).
- On-site composting for nutrient recovery and recycling of materials from the solid waste stream are seen as favourable practices.
- A significant proportion (60.7%) of respondents favour the idea of consolidating water, sanitation, and waste services into a single combined charge. However, 31.4% were negative about this, citing concerns, such as the perceived cost and the belief that they do not currently need certain services, particularly sanitation services. They also do not perceive a need for emptying or solid waste management because the organic waste is used in their gardens and other waste is incinerated. The rest did not have an opinion or were hesitant about answering.

Appendix

A.1. Political / Institutional landscape

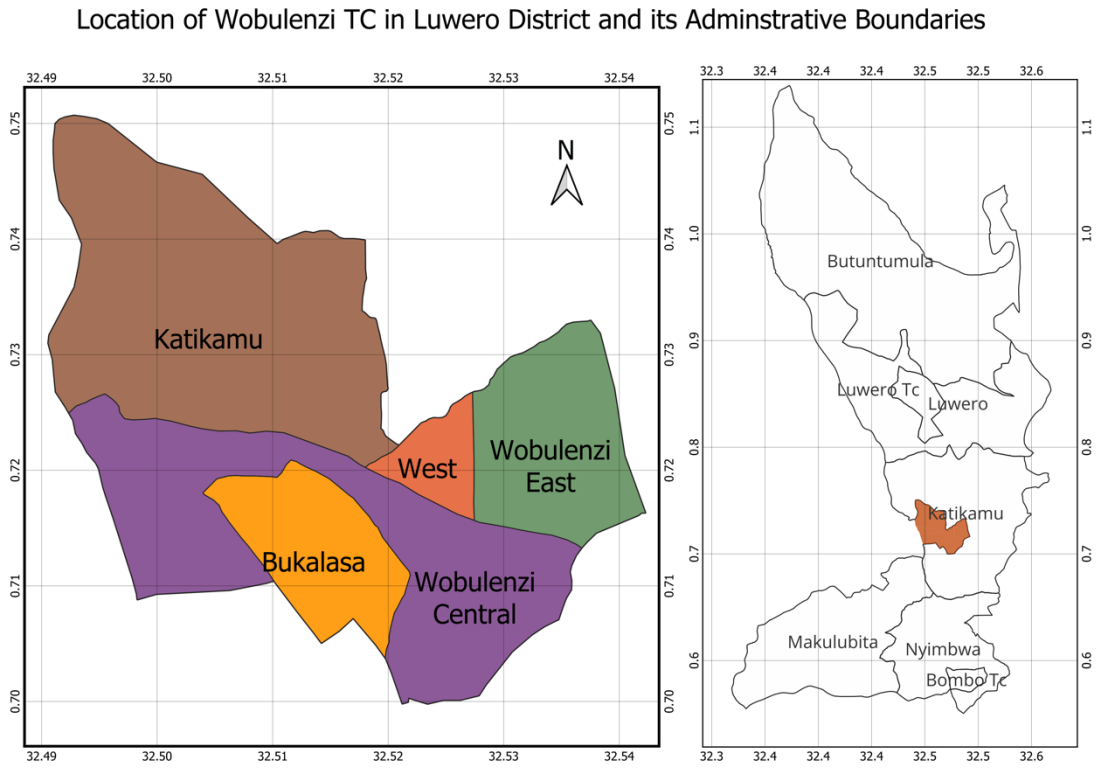

Figure 18: Wards in Wobulenzi TC (left) and location of Wobulenzi in Katikamu district (right)

A.2. Settlement areas definitions

Urbanised

High population density, concentration of administrative bodies and infrastructure and a diverse set of livelihood and income generation activities.

Peri-Urbanised

Zones of transition from rural to urban land uses located between the outer limits of urban and regional centres. Often found to be in clusters along roads.

Rural

Low population density, relatively low presence of administrative structures and government services and other infrastructure. Livelihood activities are predominantly centred on agricultural production.

A.3. Organogram of Town Council

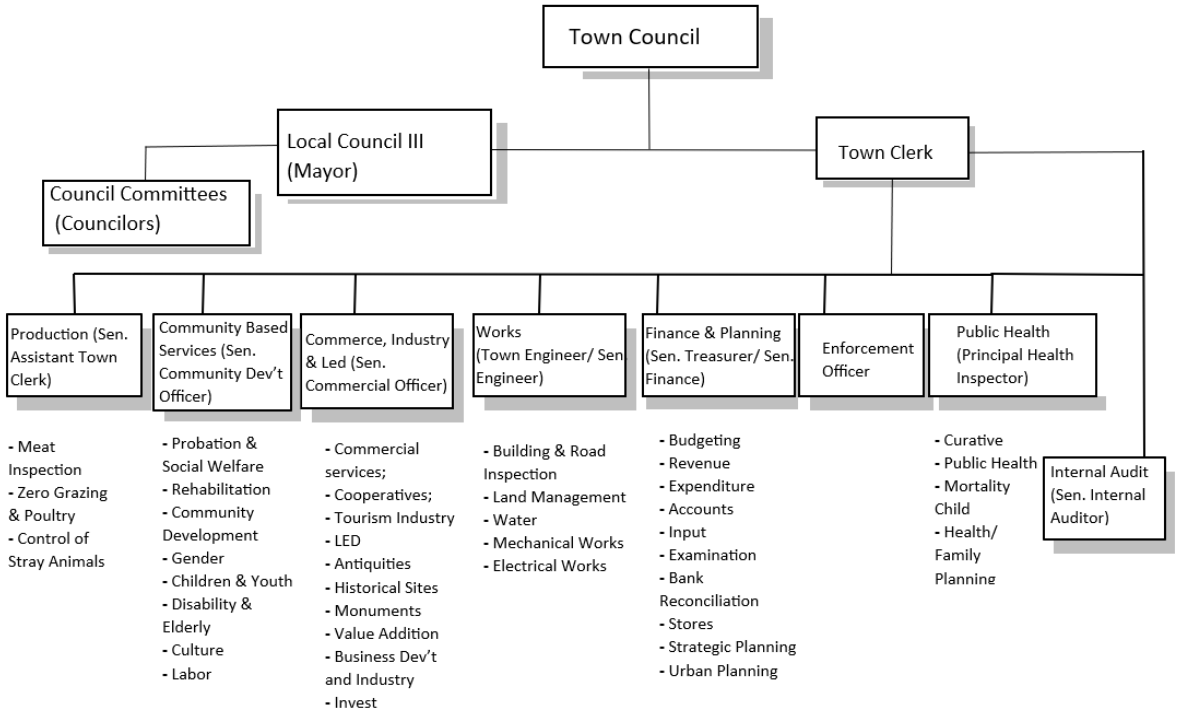

Figure 19: Organogram of Town Council structure

A.4. Flow diagrams

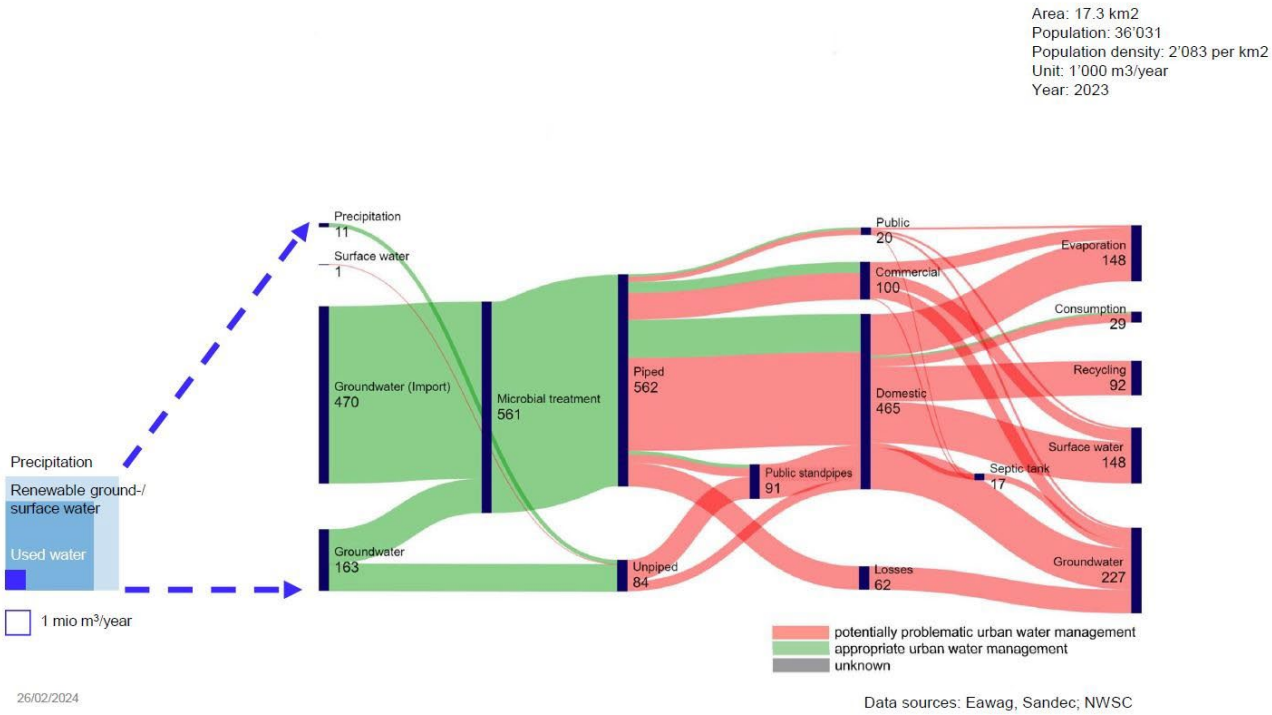

Figure 20: Water Flow Diagram in WTC, 2023

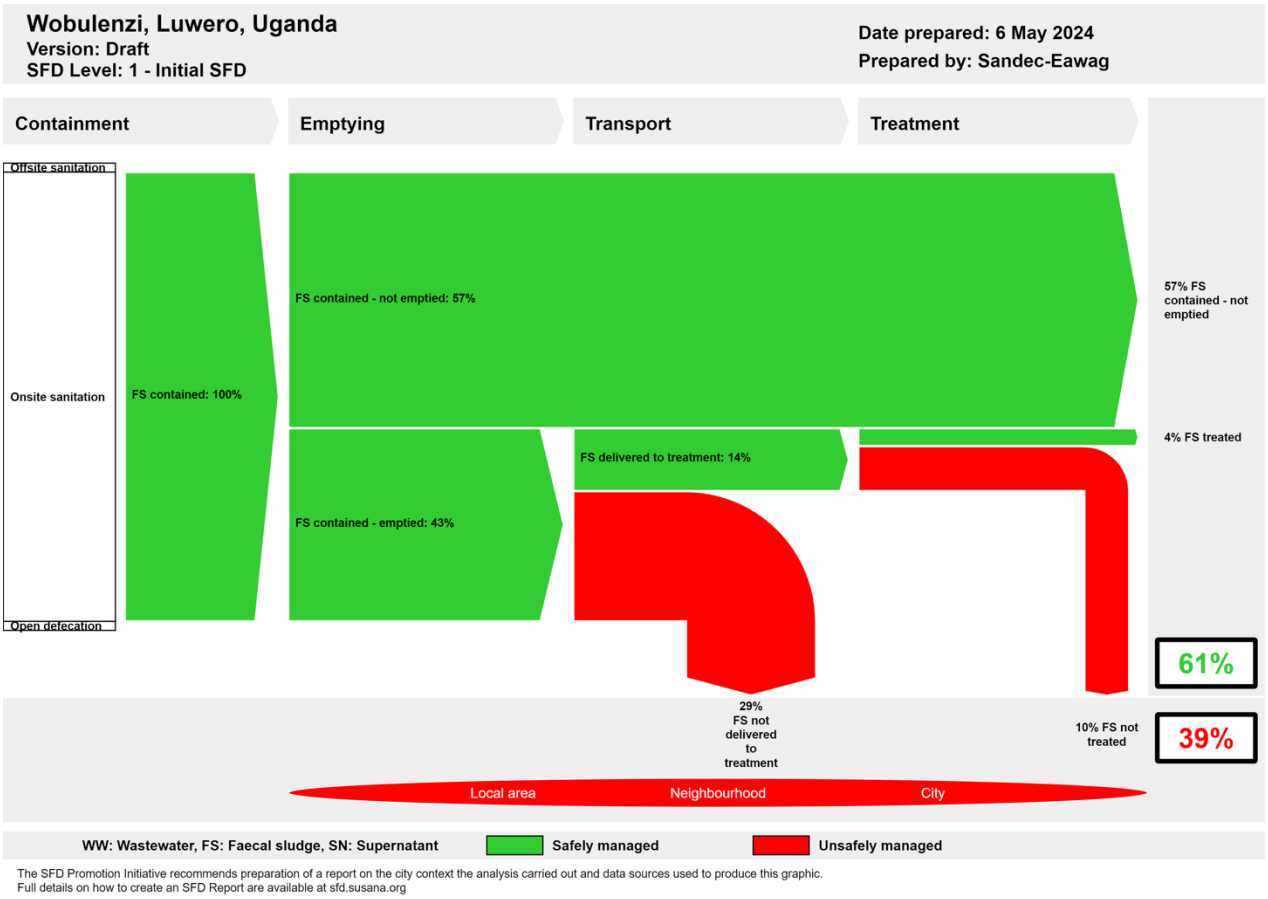

Figure 21: Excreta Flow Diagram in WTC, 2023

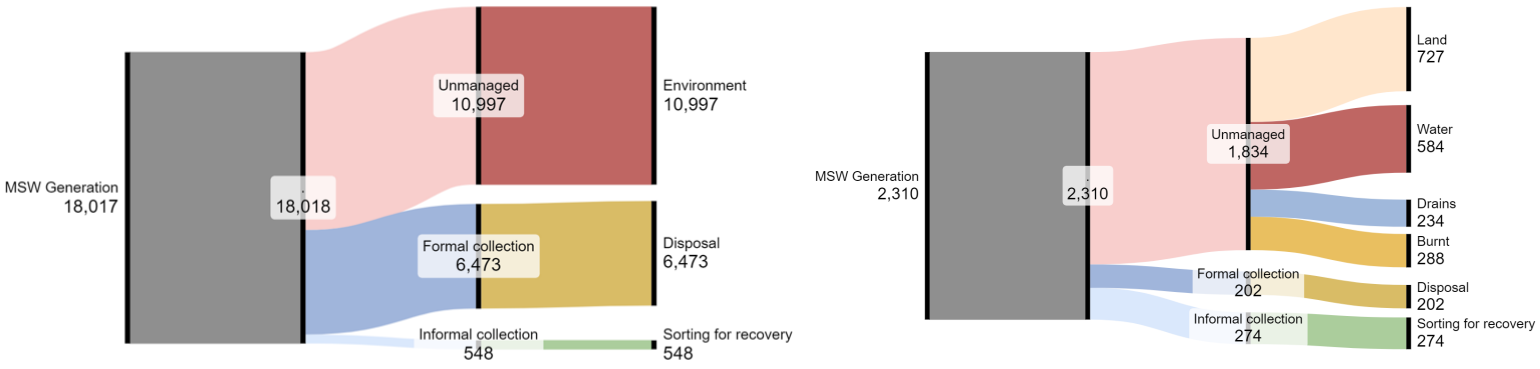

Figure 22: (a) Municipal Solid Waste Flow and (b) Plastic Waste Flow Diagram in WTC, 2023

A.5. Spatial distribution of access levels

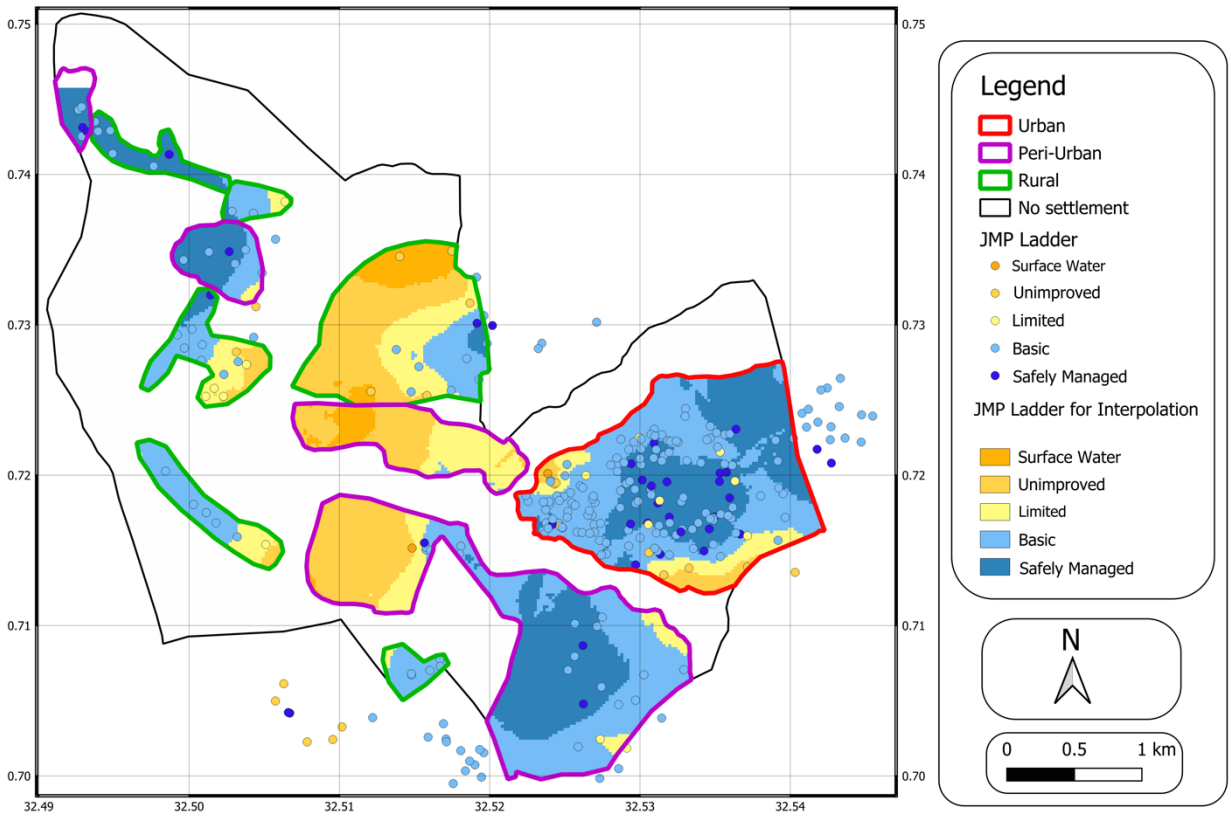

Figure 23: Spatial distribution of water services levels in Wobulenzi

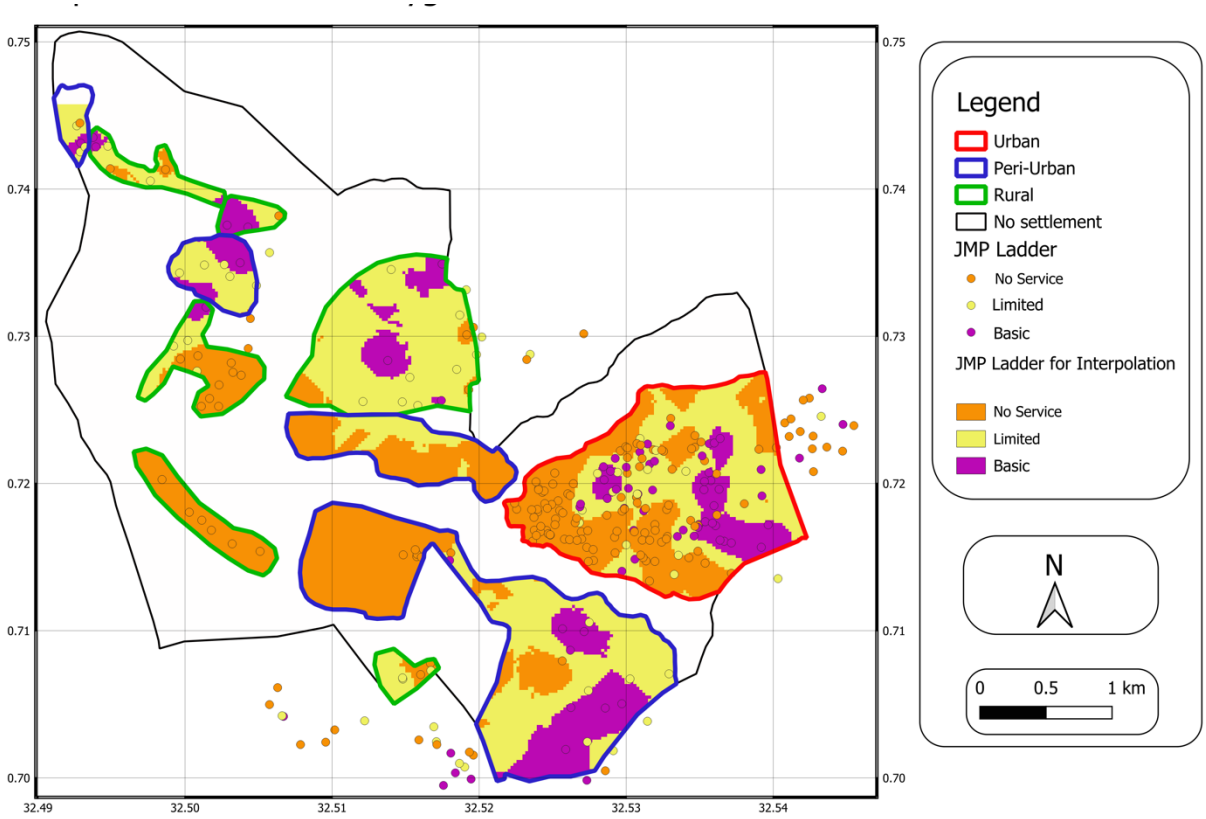

Figure 24: Spatial distribution of hygiene services levels in Wobulenzi

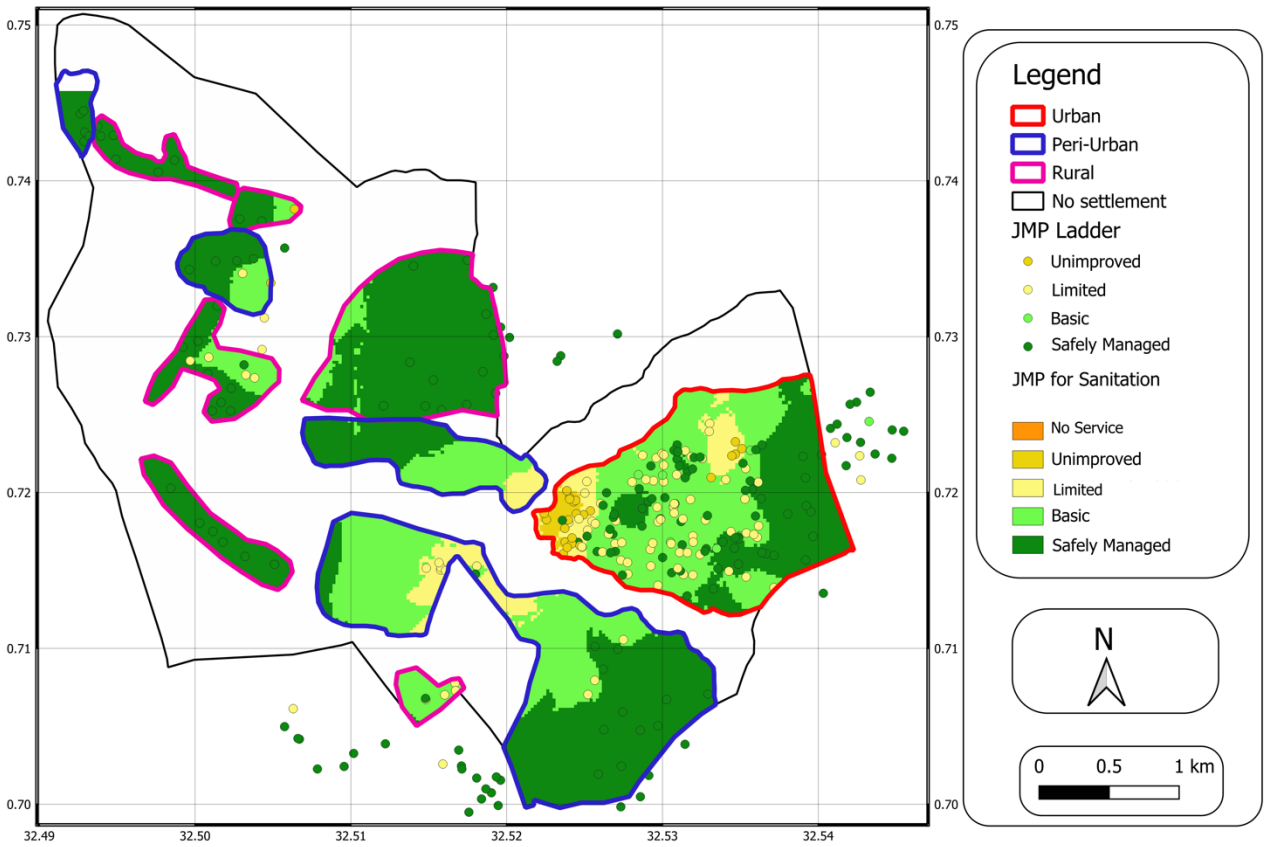

Figure 24: Spatial distribution of sanitation services levels in Wobulenzi

A.6. JMP Ladders

A.6.1. Assumptions for hygiene-sanitation

Certain assumptions were made when conceptualising the JMP ladder. In particular, data limitations on the specifics of pit latrines led to the assumption that all pit latrines connected to a containment system are improved facilities. This is based on the assumption that there is the presence of a slab - a reasonable inference supported by local observations. It was also assumed that where a containment system had an outfall, effluent discharged into soakpits or directly into the ground was considered to be safely managed. Conversely, cases where effluent flowed into a sewer, such as an open drain, or where respondents were uncertain about the destination of the outflow, were categorised as basic sanitation.

A.6.2 JMP Ladders classification

Figure 24: Classification for Water, Hygiene and sanitation regarding the JMP. Source: WHO/UNICEF JMP

A.7. Faecal sludge treatment facility in WTC

Faecal sludge treatment units

The collected (emptied) faecal sludge is transported to a treatment facility for proper treatment to ensure that the effluent meets discharge standards. In this scenario, the proposed treatment focuses on removing identified non-compliant parameters from the faecal sludge, which are categorised as solids, organics, nutrients, and pathogens. The required discharge standards for effluent involves treating the faecal sludge through a combination of various unit processes and operations. The design capacity of the FSTP in Wobulenzi is 40 m^3 per day.

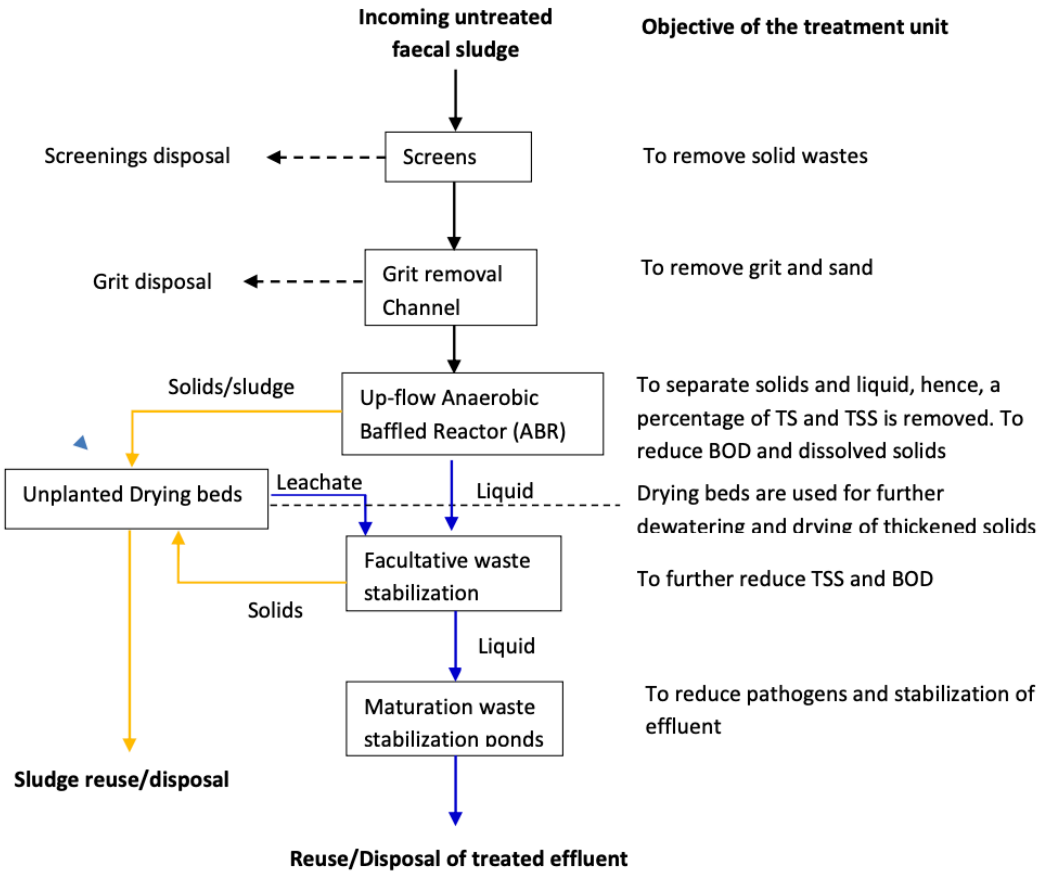

Figure 25: Scheme of the Faecal Sludge treatment plant

The faecal sludge treatment, as shown in Figure 25, is composed of the following steps:

1. Screening the faecal sludge to remove floating and suspended solids using a bar screen.
2. Passing the faecal sludge through the grit chamber to remove suspended inorganic particles, such as sand and grit.
3. Removal of suspended solids by sedimentation using a settler/thickening tank.
4. Dewatering the faecal sludge from the settler through using unplanted sludge drying beds, evaporation and drainage of the liquid through a sand/gravel media. The dried sludge is stored in a bunker to be later processed for soil enrichment.

5. Primary treatment of the wastewater from the settler with an Anaerobic Baffle Reactor (ABR) to remove organic pollutants (COD and BOD removal).
6. Secondary treatment of the wastewater, using facultative ponds to further reduce the TSS and BOD.
7. Secondary treatment of the wastewater from the facultative pond with maturation ponds in a series to reduce the pathogens and increase the stabilisation of the wastewater.

The effluent can then be discharged into the environment if it meets the national discharge standards or reused for irrigation if it meets the WHO Guidelines for safe use of wastewater, excreta, or greywater (WHO, 2006). The settled solids in ABR still contain a high proportion of water after separation. Therefore, further dewatering and drying will be required. Here, it is proposed that this is achieved through use of roofed unplanted sludge drying beds. The leachate from the unplanted drying beds is low in solids and organic matter and can, therefore, be directly loaded into the facultative ponds. Similarly, the sludge from the ponds can be loaded to the drying beds for dewatering and drying. The dried faecal sludge can be used, depending on the feasible reuse options in the area's vicinity. Additionally, a roofed shade may be included to act as a storage area for dried faecal sludge from the drying beds.

Costs and revenues:

The plant's total annual costs include maintenance, staff salaries, fuel for cesspool emptiers, and administrative expenses. The average annual Operations and Maintenance (O&M) cost is estimated at 91'499'790 UGX over a 15-year period. Revenue is derived from households' payments, fees from hotels and private institutions, and income generated from resource recovery. It is anticipated that the combined revenues from the four districts should sufficiently cover the O&M costs.

Staff and Equipment

Table 10 presents the personnel working in the FSTP and their respective responsibilities.

Table 10: Staff for the operation and the management of the FSTP

Function	Number	Level of Education	Tasks	Monthly salary [UGX]
Technical Supervisor	1	Higher National Diploma + 5 years of relevant supervisory experience	- Responsible to the Area Manager/ Engineer. - Oversees all aspects of the wastewater treatment units. - Responsible for testing the quality of the incoming faecal sludge and discharged effluent.	1'000'000
Driver	1	National Diploma	Driving and operation of the vacuum tank (cesspool emptier truck).	500'000
Care taker	2		- Grass maintenance and cleaning of pond compound. - Assisting the driver operate the vacuum tank	400'000

Desludging in the project area should be conducted using an emptier truck, capable of emptying septic tanks and lined pit latrines. The capacity of the current emptier truck is 8 m^3, which allows it to effectively remove waste from these sanitation facilities.