Tanzania

Rapid Needs Assessment for Low Cost Sanitation Concept for Kyela Town

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LIST OF ABBREVIATIONS

CBD	Central Business District
CBO	Community based organisation
DALDO	District Agricultural and Livestock Development Officer
GDC	German Development Cooperation
JICA	Japanese Development Cooperation
KYUWSA	Kyela Urban Water Supply and Sanitation Authority
MUWSA	Mbeya Urban Water Supply and Sanitation Authority
NGO	Non-governmental organisation
PPPs	Public private partnerships
SME	Small scale enterprise
TSh	Tanzanian Shilling
UDDT	Urine diverting dry toilet
UWSSAs	Urban Water Supply and Sanitation Authorities
WSDP	Water Sector Development Programme

DEFINITIONS

Are following definitions are from the Compendium of Sanitation Systems and Technologies (Tilly et al., 2008).

Compost is the earth-like material that is the result of decomposed organic matter. Generally compost has been hygienized sufficiently that it can be used safely in agriculture. **Co-composting** means composting of human excreta and / or dewatered sludge and organic waste.

Excreta consists of urine and faeces that is not mixed with any flushing water. Excreta is small in volume, but concentrated in nutrients and pathogens. Depending on the quality of the faeces it is solid, soft or runny.

Faeces refer to (semi-solid) excrement without urine or water. Each person produces approximately 50l m per year of faecal matter. Of the total nutrients excreted, faeces contain about 10% N, 30% P, 12% K and have 107–109 faecal coliforms /100 ml.

Faecal sludge is the general term for the raw (or partially digested) slurry or solid that results from the storage of blackwater or excreta. The composition of faecal sludge varies significantly depending on the location, the water content, and the storage. For example, ammonium (NH4-N) can range from 300–3,000 mg/l while helminth eggs can reach up to 60,000 eggs/l. The composition will determine the type of treatment that is possible and the end-use possibilities.

Greywater is the total volume of water generated from washing food, clothes and dishware as well as from bathing. It may contain traces of excreta and therefore will also contain pathogens. Greywater accounts for approximately 60% of the wastewater produced in households with flush toilets.

Storm water is the general term for the rainfall runoff collected from roofs, roads and other surfaces. It is the portion of rainfall that does not infiltrate into the soil.

Urine is the liquid waste produced by the body to rid itself of urea and other waste products. In this context, the urine refers to pure urine that is not mixed with faeces or water. Depending on diet, human urine collected during one year (ca. 500l) contains 2 – 4 kg nitrogen. With the exception of some rare cases, urine is sterile when it leaves the body.

A **conservancy tank** is a watertight chamber made of concrete, fibreglass, PVC or plastic, for the storage of wastewater and greywater. In a conservancy tank no treatment occurs. When the conservancy tank is full, the wastewater has to be removed by a vacuum truck or another vehicle equipped with a motorized pump and a storage tank for emptying and transporting wastewater. As the wastewater is highly pathogenic prior to treatment, human contact, direct agricultural applications or dumping must be avoided, thus a proper faecal sludge management is needed. The removed wastewater must be transported to a (wastewater) treatment plant.

A **septic tank** is a watertight chamber made of concrete, fibreglass, PVC or plastic, for the storage and treatment of wastewater and greywater. Settling and anaerobic processes reduce solids and organics, but the treatment is only moderate. A septic tank should typically have three chambers. The first chamber should be at least 50% of the total length, because most of the solids settle out in the first chamber. The design of a Septic Tank depends on the number of users, the amount of water used per capita, the average annual temperature, the pumping frequency and the characteristics of the wastewater. The retention time should be designed for 48 hours to achieve moderate treatment. Generally, septic tanks should be emptied every year, although they should be checked regularely to ensure proper functioning.

EXECUTIVE SUMMARY

The goals of this survey were (1) to assess the present situation in Kyela Township, Tanzania in the field of sanitation, comprising of water supply, human excreta and wastewater management, greywater, storm water drainage and solid waste management and (2) to outline the feasibility for a comprehensive low-cost sanitation concept for Kyela Township.

SITUATION ANALYSIS

Water supply

Kyela town's water supply is covered by the central water supply system and private shallow wells. The central system is covering its water demand from two boreholes and from Kanga Group Scheme, a river intake at Mbambo (about 40km North of Kyela Township). The total production from the three sources is currently about 4,200m³, with a daily demand of about 3,140m³. The rest is unaccounted for water. Currently, about 35% of the daily water demand is covered by the Kanga Group Scheme and 65% from the boreholes within town.

The quality of the extracted water is monitored quarterly and results are within Tanzanian Standards. Water from the Kanga Group Scheme is chlorinated before entering the supply network. Boiling of the water is generally recommended by the Kyela Urban Water Supply and Sanitation (KYUWSA), as the supply pipes are old and leaking and cross-contaminations cannot be excluded.

The water from the boreholes is pumped to elevated concrete tanks, with a capacity of about 225m³ and 90m³ respectively. Both tanks supply the water network by gravity. The water from Kanga Group Scheme is transported by gravity and is directly connected to the distribution line in Kyela Town.

The network supplies about 2,600 customers (by October 2011) and most commercial and institutional buildings. Only 600 are equipped with water meters. Nearly 50% of the costumers are not paying their water bills and about a quarter of customers already have been disconnected from the network. The expected income per month is 12 million TSh, but only 6 million TSh are generated at the moment.

Human excreta and greywater

The majority of people in Kyela town have a private toilet. The most commonly used facilities are traditional pit latrines and a small share of (mainly pour) flush toilets. The latter are normally connected to an unsealed (septic) tank or a soakage pit.

As the groundwater table is very high, pits and tanks are normally not very deep. It must be assumed that a high proportion of faecal sludge infiltrates into the soil and directly contaminates the groundwater. Certainly during the rainy season it is one of the main problems within the town.

Greywater is generated mainly from bathing, washing kitchen utensils and clothes as well as house cleaning. Most of the greywater is already produced in the yards and soaks away directly at the source.

Kyela Township has four public toilets. All of them are operated privately. The toilets are permanently supervised and frequently cleaned. The individual toilets are connected to watertight (septic) tanks, which are covered with concrete.

Kyela Township has no public sewer. Households generally do not empty their pits. When the pit fills a new one is constructed. One of the main challenges Kyela Township faces is the lack of a vacuum truck and that no proper dumping / treatment site exists. Currently a pumping truck comes from Mbeya City Council, which is very expensive.

The sanitation budget is far from cost-covering, the expenses (47,350,000 TSh in the financial year 2011 / 2012) are higher than the generated income (26,000,000 for solid waste collection fees).

Storm water drainage

The groundwater table in Kyela Township is very high. As the mean annual rainfall in the area is between 2000 and 3000mm per year and the topography of Kyela Township is nearly flat, large parts of the town get flooded during heavy rainfalls.

The major drainage channel is going from East to West through the central business district (CBD) leading into a small river, which drains into Lake Nyasa. Three more drainage channels are planned. For the unplanned and peri-urban areas some minor drainage channels exist. They either drain to several unplanned ponds, which store water run-off up to a certain extent during peak rainfalls. These ponds have almost no planned run-off and rely mainly on evaporation.

The drainage channels are maintained by the Township Authority and are cleaned regularly, at least before rainy season. Any littering as well as waste water or greywater intake is prohibited and executed accordingly. In practice, the channels are misused for littering.

Solid waste management

Neither the amount nor the characteristics of solid waste are known. But it is guessed that the share of organic waste is about 60-80% of the municipal waste. The remaining 20-40% are mainly plastics like thin PE bags or any other plastic wrapping material which are found next to roads or blown away from the wind throughout the town. The District Hospital in town additionally produces hazardous and infectious wastes.

Solid waste collection is outsourced to a private operator. Waste bins are provided along the main roads and the market and people are encouraged to throw their waste into them. For the moment, this service is offered for free, only commercials pay at the moment, but shall be charged in future. Nevertheless, most of the refuse especially from households is still not collected. The refuse collected is transported with a truck to an unprotected dump site in the West of Kyela Township.

Households, restaurants, guest houses, enterprises, etc. outside of CBD have no collection service in place. The remaining solid parts are openly dumped outside of the yards or in pits in order to be burnt as soon as sufficient material has been collected.

In Kyela Town no formal recycling of specific waste is taking place nor any kind of waste separation. Only organic waste on household level for livestock feeding and medical waste in the hospital is collected separately. Plastic water bottles are collected, mainly to be reused for other purposes.

Solid waste collection is currently the only income generator in the sanitation sector of Kyela Township Authority. In the last financial year 2010/2011 about 26 million TSh was collected.

LOW COST SANITATION CONCEPT FOR KYELA TOWN

System approach

The concepts suggested are based on a system approach. A sanitation system is considered a multi-step process where products are managed from the point of generation to the point of re-use. Hence a sanitation system comprises five process steps. These are the user interface, collection / storage, emptying / transport, treatment, use / disposal. Each step involves a number of technologies, which have to be selected according to the local situation.

A sanitation system also includes specific operation and maintenance, as well as management procedures to ensure that the system functions safely and sustainably. The question "Who operates?" must go hand in hand with any technological decisions.

Financial partnerships

The improvement of the sanitation situation always needs financial investments. Depending on the system, these costs may be low or high, but a certain amount of money is always needed. Generally there is a will to improve the situation. But options proposed must be financially affordable, especially for the households, since they bear the main costs for any improvements. Including the users in sanitation planning will increase the sustainability of any sanitation system.

Apart from financing of infrastructure (hardware), software components also have to be considered. Experiences have shown that hardware alone is not sufficient! Thus improvements in sanitation always consist of a hardware and a software component. For a sustainable sanitation system, the combination of hardware and software must go hand in hand.

Different options for financing sanitation in Kyela Township deserve exploration. These are (i) own resources (e.g. solid waste collection fees), (ii) outsourcing of public services (e.g. solid waste

collection and emptying of septic and sludge holding tanks), (iii) external resources from private and public donors, (iv) capital financing by users (e.g. toilet construction), (v) public subsidising and (vi) public private partnerships.

Sanitation concept for Kyela Township

The challenge to outline the feasibility for a comprehensive low-cost sanitation approach for Kyela Town is highly versatile. The framework conditions are mainly defined by a flat landscape, a very high groundwater level, an unreliable electricity supply, regular flooding of the town as well as limited financial and human resources. That leads to a situation which is not to be handled by a single technology. Thus, this study suggests a variety of technologies which have to be compiled to sanitation systems, consisting of hardware as well as software components, like awareness building and an operation strategy.

The different systems have in common that a proper wastewater and faecal sludge management is needed. There are different options possible and all have their pros and cons, likely a compromise solution will be chosen. However, the consultant recommends investigating in a detailed study in order to find the best solution and not to follow the common practise to construct wastewater stabilisation ponds without considering other options.

Four different sanitation systems suitable for Kyela Township have been identified:

System 1: Waterless sanitation system with (ventilated) improved pit latrine.

This option corresponds with the common practise of using pit latrines and the above described basic service level. Although the disadvantages are known, especially the high risk of groundwater contamination, it is the most realistic alternative in a short term perspective. This alternative should be seen as a compromise and a first step to improve the current situation.

User Interface:	Improved pit latrines with slab, ventilation and a hand washing facility.
Collection / storage:	Single or double pits, with a lines pit or the connection to a conservancy tank. Greywater is infiltrated into the ground with a soak pit.
Emptying / transport:	Emptying of conservancy tank with a vacuum truck or tank.
Treatment:	Sludge drying bed, a trickling filter or a wastewater stabilisation pond.
Use / disposal:	The effluent can be used for irrigation, groundwater recharge, discharge via a percolation trench or water body recharge. Treated faecal sludge can be used in agriculture or disposed via dumping.

System 2: Waterless sanitation system with urine diverting dry toilet and waterless urinal.

Urine diverting dry toilets (UDDTs) would be completely new in Kyela Township. If this option is chosen, intensive interactions with the community will be required by starting with a few demonstration units of UDDTs including waterless urinals as well as a hand washing facility. UDDTs are considered an option, because they are very suitable for the environment in Kyela.

User Interface:	UDDT, waterless urinal and a hand washing facility.
Collection / storage:	Containers for faeces and tanks for urine. Greywater is infiltrated into the ground with a soak pit.
Emptying / transport:	Faeces and urine are transported by human / animal or by motorized power.
Treatment:	Co-composting (faeces and organic waste) to produce a save soil conditioner.
Use / disposal:	Compost for agricultural use and urine as nitrogen fertilizer.

System 3: Pour flush sanitation system connected to (communal) three chamber septic tank.

Be aware that the following suggestion, though it is neither sustainable from an environmental point of view, nor complies with national standards for wastewater treatment, it is still one of the most realistic possibilities.

User Interface: Pour flush toilets.

Collection / storage: The pour flush toilets together with the greywater are connected to a household or communal three chamber septic tank, with on-site infiltration.

Emptying / transport: The sludge should be removed annually using a vacuum truck or tank.

Treatment: A sludge drying bed including a treatment for leaching water, a trickling filter, or wastewater stabilisation ponds.

Use / disposal: The effluent can be used for irrigation, groundwater recharge, discharge via a percolation trench or water body recharge. Treated faecal sludge can be used in agriculture or disposed via dumping.

System 4: (Simplified) sewer with (decentralised) wastewater treatment plant.

A sewer network connected to a centralised wastewater treatment plant should be considered in a long-term perspective. The construction of a sewer network is often cheaper than operating many septic tanks in densely populated areas. As it is not possible to construct a gravity sewer in Kyela town, different alternatives should be looked at like the possibility of using solar pumps, a simplified sewer and sewer discharge stations.

User Interface: Pour or full flush toilets are connected to a sewer.

Collection / storage: No collection and storage needed.

Emptying / transport: The wastewater is transported via a (simplified) sewer to further treatment.

Treatment: Trickling filter or decentralised wastewater treatment systems, like constructed wetlands.

Use / disposal: The effluent can be used for irrigation, groundwater recharge, discharge via a percolation trench or water body recharge. Treated faecal sludge can be used in agriculture or disposed via dumping.

Compatibility of the systems

The four systems suggested are not an "either – or" decision but rather alternatives adaptable for different areas within Kyela town. They are suitable for parallel implementation as well as a stepwise approach. The systems are generally suitable for different areas within Kyela Township, some of them can use a common infrastructure like a centralised wastewater treatment plant and can be upgraded to a sewer system in a long term perspective.

FROM PLANNING TO IMPLEMENTATION

During the last years, a range of planning approaches have been developed. The common goal is to enable urban communities and municipalities in low-income countries to plan and implement cost effective sustainable sanitation services. Two participatory planning approaches are the basis for further recommendations within the frame of this study, (i) The NETSSAF Participatory Planning Approach (NETSSAF, 2008) and (ii) Community-Led Urban Environmental Sanitation Planning (Lüthi et al. 2011).

This 7 step approach describes a possible strategy to improve the sanitation situation within Kyela Township. These steps are (1) Launch of the planning process, (2) Creation of demand, (3) Detailed assessment of the current situation, (4) Prioritisation of community problems and validation, (5) Identification of service options, (6) Development of an action plan and Implementation of the action plan.

1 BACKGROUND

1.1 Objectives of the study

ESC Consulting Austria was commissioned by the GIZ/German Development Cooperation (GDC) to carry out a Rapid Needs Assessment for Low-Cost Sanitation Concept for Kyela Township, in the framework of the Water Sector Reform Programme in Tanzania.

The goal of this mission was twofold:

- To sum up the present situation in Kyela Township in the field of sanitation, comprising of water supply, human excreta and wastewater management, greywater, storm water drainage and solid waste management.
- To outline the feasibility for a comprehensive low-cost sanitation concept for Kyela Township.

The mission took place form 2.-16. November 2011, with the actual field work in Kyela Township from 4.-11. November 2011. The study was carried out by Elke Müllegger, ESC Consulting Austria.

1.2 Limitations of the study

The following study is a rapid needs assessment. Within the given time-frame it was not possible to conduct a comprehensive survey. The consultant relied on the availability of existing data, which was unfortunately very limited. Most data provided in this study, except where otherwise specified, is based on personal communication during the field visit in Kyela Township. For any detailed planning of sanitation infrastructure such as a wastewater treatment plant, further investigations are highly recommended.

Just recently, an additional study on water supply and sanitation in Kyela town has been conducted by seureca and NETWAS Tanzania Ltd (2011), within the framework of the Water Sector Development Programme (WSDP). Kyela was one of 10 small towns within Mbeya region were a detailed situation analysis was implemented, in order to improve the water supply and sanitation services. The study will ultimately involve the construction of the identified improvements (seureca and NETWAS Tanzania Ltd, 2011).

1.3 Sustainable Sanitation

Commonly, authorities are implementing sanitation technologies in bits and pieces but without a clear vision. They implement what consultants recommend, but not taking time to question the proposed technologies and discuss about local needs. However, this study and the one of seureca and NETWAS Tanzania Ltd (2011) are a good basis for Kyela Township Authority to develop a sanitation strategy and to plan in a sustainable and participatory way. Especially for sanitation, a clear action plan on a short, middle and long-term basis helps to reduce cost, improve the environmental impact and the heath situation.

Within the context of this study, sanitation includes human excreta and greywater management, storm water drainage and solid waste management. It is further in line with the definition of sustainable sanitation, provided by the Sustainable Sanitation Alliance[1] (SuSanA, 2011): "The main objective of a sanitation system is to protect and promote human health by providing a clean environment and breaking the cycle of disease. In order to be sustainable, a sanitation system has to be not only economically viable, socially acceptable, and technically and institutionally appropriate, it should also protect the environment and the natural resources."

[1] Link to homepage: www.susana.org

2 METHODOLOGY

2.1 Direct observations

The selection and visits of the areas were guided by Mr. Oswald Mwakalasi (Township Executive Officer) and Mr. Behenobi Mutta (District Town Planner), who provided an insight into the prevailing sanitation conditions, current sanitation practises as well as technologies and services used (Figure 1). The consultant had the possibilities to visit all relevant sites in Kyela Town, with the focus on so called "hot spots".

Additional information was gathered through various transect walks throughout the town. The consultant visited different areas on her own, in order to get a deeper impression and to add on to information provided through interviews. Unfortunately conversations were only possible to a very limited extend, due to language barriers.

Figure 1: Direct observation of a shallow well guided by Mr. Mwakalasi

2.2 Semi structured interviews

The consultant conducted various formal and informal semi structured interviews with local authority representatives. As sanitation is a cross-cutting issue, the main focus was on a holistic approach and to talk with representatives from different departments. A comprehensive list is provided in → Annex 7.1, mentioning here only the focus persons interviewed:

- Mr. Oswald Mwakalasi, Township Executive Officer.
- Mr. Behenobi Mutta, District Town Planner.
- Mr. Abu Mkungume, Managing Director of Kyela Urban Water Supply and Sanitation Authority (KYUWSA).
- Mr. Erasto Mbunga, Health Officer.

2.3 Formal meetings

The information gathered in this report is additionally based on two formal meetings with various representatives from the Township Authority and the District Council. The first meeting (4.11.2011) was held in the office of the District Executive Director, mainly to introduce the consultant, the ongoing activity and to get to know the main challenges the different departments are faced with. A participation list is provided in → Annex 7.1.

A second meeting (10.11.2011) was held towards the end of the actual field work of the consultant. The venue was the meeting room of Kyela District Council. The aim of the meeting was to discuss the main findings of the consultant and proposed solutions in order to overcome the main sanitation challenges within Kyela Township. The list of participants is provided in → Annex 7.1.

3 KYELA TOWN - BASIC INFORMATION

3.1 Kyela Township Authority

The Township Authority of Kyela was established in 2004, thus it is a relatively new town. To date, the Authority has not taken full control and responsibility of the township activities and some activities are still under Kyela District Council, for example town planning and agriculture. By the

coming financial year, starting with the 1st of July 2012, it is expected that the transformation from Township Authority to Town Council is finalized.

The township's income is currently entirely based on own resources only, for example different types of fees and revenues for example from renting fees from market stalls, solid waste collection fees or trade revenues. The total income of the financial year 2010/11 was about 253 million TSh. The one for the financial year 2011/12 is expected to be in total 267 million TSh.

3.2 Geographic location and administrative organisation[2]

Kyela is the capital of the same-named District, about 120km south of the regional capital Mbeya. It is located in the South-West of the Republic of Tanzania, and forms part of the East African Rift Valley at a place where it engulfs Lake Nyasa. The boundaries of the township are river Kiwira to the West and South, Kikusya –Matema Beach road to the North up to Tenende river culvert. To the East, the boundary is marked by a series of cadastral beacons separating the township from the rural settlements of Tenende, Lukuyu, Kajunjumele, Kapwili and Kingila.

Kyela Township is the administrative and economic centre of Kyela District and accommodates the Township Authority as well as the District Council, the communal hospital, a number of primary and secondary schools, food processing industry (mainly cocoa, rice and palm oil production) and the central market of the whole District.

The population of Kyela Township from the National Population and Housing Census 2002 is 28,741 residents, with a total of 5,817 households and an average household size of 4.9 people. Typically for most urban centres in Tanzania, the population of Kyela Township has increased very fast over the last three decades, with an estimated annual growth rate of 3.2%. For 2018 it is expected that about 45,000 people will live permanently in Kyela Township (Table 1).

Table 1: Kyela Township population projection, 2002 - 2018.

Area	2002 (Census)	2008	2018
Kyela Town	28,741	32,575	44,635
Kyela District	173,830	200,412	254,052

Kyela Township covers an area of about 3,370ha, characterised by a very flat topography, with an elevation of more or less 495 msl. It is composed of Kyela ward in which 6 villages are incorporated, namely Kyela Kati, Bondeni, Ipyana, Ndandalo, Nkuyu and Itunge. Among the administrative division in villages, Kyela Town consists of four differently characterised areas:

- **Category 1 - the Central Business District** (CBD) is the old centre of the town, from a time when it started as a trading centre. The CBD is characterised by a high population density and the main commercial activities, like the main market, guest houses, eating places and small shops. Although a few public and institutional buildings are situated in the centre of Kyela, like the communal hospital.
- **Category 2 - the planned area** surrounds the CBD, using the main Mbeya - Lake Nyasa road as a natural boarder. It consists of mainly planned residential areas with some commercial and institutional buildings.
- **Category 3 - the unplanned or squatter proliferation area** affiliating the planned area. In this area planning regulations are not enforced and customary land tenure is the dominating practice.
- **Category 4 - the peri-urban, agricultural area** characterised by small scale farming with scattered homesteads.

[2] Adopted from the Kyela Township Interim Land Use Plan 2008-2018 (Ministry of Lands, Housing and Human Settlements Development, 2008).

→ Annex 7.2 shown satellite images from Kyela Township and → Annex 7.3 contains the actual land use plan from 2008 as well as the proposed land uses up to 2018 (Ministry of Lands, Housing and Human Settlements Development, 2008).

3.3 Hydrogeological situation[3]

The mean annual rainfall in the area is very high, ranging from 2000 to 3000mm, with the main rainy season from November to June and the heaviest rainfalls occurring in April and May. The groundwater recharge depends on the amount of rainfall as well as groundwater through flow from the surrounding mountains and perennial rivers.

The geology of Kyela District belongs to Karoo sediments super-group, Rungwe volcanic and younger basin sediments. Geo-morphologically, Kyela district is located on the Kipengere ranges and on the low land in the Lake Nyasa basin of Western rift system.

The sandy and gravely beds intercalated in the plane sediments have high porosity and high transmissivity storing much groundwater. The cycle of bed alternation varies from place to place, but a good aquifer of sandy beds exists everywhere in the plain, and is confined by the clay-rich beds. At the same time, the existing geological structures allow both aquifer layers to be contaminated by infiltration from pit latrines as well as other non-protected polluters like car washes, waste dumps and petrol stations.

3.4 Socio-economic condition[4]

The main employment sector in Kyela Township is agriculture, with up to 80% of the working population. The remaining 20% are either employed by the public sector or in the commercial, small-scale industry or informal sector. Agriculture contributes significantly to the district income.

Agriculture and farming activities characterize the town's picture, with more than half of the township area used for small-scale agriculture. Cocoa is the major cash crop produced, exclusively for export. Maize, cassava, paddy rice, groundnuts and beans are the major food crops. Farming is generally practised during the rainy season. Due to the high water table within the township and the proximity to Kiwira river, with irrigation it can be extended through out the year. Livestock keeping is practised on a subsistent level, which are mainly cattle, goats, sheep, donkeys and poultry.

The main type of small scale enterprise (SME) is food processing, namely oil extraction mills for palm oil production, maize and rice extracting mills (Figure 2) as well as raw cocoa packing for export.

Figure 2: Maize and rice extracting mills.

[3] Adopted from Short Report of Sanitation in Kyela Town (Daniel Schimanowski, 2011).
[4] Adopted from the Kyela Township Interim Land Use Plan 2008-2018 (Ministry of Lands, Housing and Human Settlements Development, 2008).

Formal and informal trade and commercial activities are mainly concentrated within the CBD. These are wholesale and retail trade, guest houses, bars and small shops, as well as hand-craft like carpentry, welding and bicycle repairs.

Generally it can be assumed that due to the strong economy of the town, 90% of the town residents earn more than a 1,000,000 TSh per month (seureca and NETWAS Tanzania Ltd, 2011).

4 SITUATION ANALYSIS

4.1 Water supply

The main information on water supply was provided by Mr. Abu Mkungume, the Managing Director of Kyela Urban Water Supply and Sanitation Authority (KYUWSA). A more detailed situation analysis is provided by seureca and NETWAS Tanzania Ltd (2011).

4.1.1 Institutional set-up and legal framework

The Kyela Urban Water Supply and Sanitation Authority was founded in 2004, with the main responsibility to operate, maintain and manage the water supply scheme of Kyela and Ipinda. KYUWSA is classified as a category C water authority. Urban Water Supply and Sanitation Authorities (UWSSAs) under this category partially meet their operation and maintenance costs and require government support in paying for power supply and salaries of the permanent employees.

Since the establishment of KYUWSA, Mr. Abu Mkungume is the Managing Director. He is retiring by end of 2011. His successor is not yet appointed, thus the strategy for future developments may be defined differently by 2012.

KYUWSA is under the Ministry of Water, Commercial Department and has to streamline any activities with the Township Authority and the District Council. The development of a Water Supply and Sanitation Board is currently underway. The Mbeya Urban Water Supply and Sanitation Authority (MUWSA), responsible for managing the municipalities within Mbeya region, is supporting KYUWSA in terms of human capacity and know-how. Mr. Abu said that this support is urgently needed because KYUWSA is completely understaffed. MUWSA capacity is used on a regular basis, especially for specific know-how on pumping or other technical issues.

The legal framework for water supply is provided mainly by the following acts:

- The Water Supply and Sanitation Act, 2009.
- The Public Health Act, 2009.
- The Water Resources Management Act, 2009.

Further details on the institutional and legal framework are provided by seureca and NETWAS Tanzania Ltd. (2011).

4.1.2 Water sources

Kyela town's water supply is covered in two different ways:

(a) The central water supply system and

(b) Shallow wells

The central system is covering its water demand from two boreholes (borehole 1 next to the police station and borehole 2 next to the hospital) and from a river intake at Mbambo (about 40km North of Kyela Township), commonly known as Kanga Group Scheme. The boreholes are relatively new. They were drilled in 2007 with financial support from the Japanese Development Cooperation (JICA). Both boreholes have a depth of 72m, with a capacity of 72m³/h and a pump capacity of 60m³/h (seureca and NETWAS Ldt., 2011). According to Mr. Abu they have enough yield throughout the year.

The total production from the three sources is currently about 4,200m³, with a daily demand of about 3,140m³. The rest is unaccounted for water, meaning that nearly a quarter of the production is lost as leakage. Currently, about 35% of the daily water demand is covered by the Kanga Group Scheme and 65% from the boreholes within town. Figures from a former survey (Ministry of Land, Housing and Settlement Development, 2008) are slightly higher, with a total production capacity per day of 4,810m³. Detailed figures are summarised in Table 2.

Table 2: Total production capacity of water sources, 2008 (Ministry of Lands, Housing and Human Settlements Development, 2008) and 2011(Mr. Abu Mkungume, KYUWSA).

	2008		2011	
	m³	%	m³	%
Kanga Group Scheme	1,930	40	1,470	35
Boreholes	2,880	60	2,730	65
TOTAL	4,810	100	4,200	100

Table 3 provides figures reported by seureca and NETWAS Ldt. (2011) which differ slightly from the numbers provided in Table 2.

Table 3: Water production of water sources supplying Kyela Town (seureca and NETWAS Tanzania Ltd, 2011).

Water Source	Design capacity (m³/d)	Present capacity (m³/d)
Kanga Group Scheme	4,900	1,930
Borehole Police Station	1,200	1,080
Borehole Hospital	1,200	1,080
TOTAL	**7,300**	**4,090**

The figures visualise the current trend of a reduced water supply from Kanga Group Scheme. The gravity scheme supplies about 18 villages and towns located along the way to Kyela Town. There are no flow-measuring devices at the intake nor at the off-takes to each village that can give an indication of the amount of water abstracted from the intake and distributed to each village (seureca and NETWAS Tanzania Ltd, 2011). Over the long term, the water from Kanga Group Scheme will be reduced constantly and replaced with additional boreholes within the town area.

The domestic and non-domestic water demand up to 2030 was calculated by seureca and NETWAS Ldt. (2011) and is summarized in Table 4.

Table 4: Projected water demand 2010 – 2030 (seureca and NETWAS Tanzania Ltd, 2011).

	2010	2015	2020	2025	2030
Population served	36,444	41,941	49,976	54,546	61,623
Domestic demand (m³/d)	2,077	2,496	2,975	3,518	4,129
Non-domestic demand (m³/d)	727	873	1,026	1,189	1,373
Total demand (m³/d)	2,804	3,369	4,001	4,708	5,501
Average domestic demand (m³/d)	57	60	62	65	67

The quality of the extracted water is monitored quarterly and within Tanzanian Standards. The water from Kanga Group Scheme is only at an acceptable limit, mainly due to turbidity problems and E. Coli contamination during rainy season. The extracted water from the boreholes has drinking water quality. According to Mr. Abu, currently the only problem is a kind of algae, which is harmless for human and

animal consumption. The algae is only clogging the water meters. An increasing problem will be the cross-contamination of boreholes from pit latrines and leaking septic tanks respectively. Figure 3 shows the borehole at the police station, which is in close vicinity of an unsealed waste water tank. However, the Kanga Group Scheme is chlorinated before entering the supply network in Mbambo. Boiling of the water is generally recommended, as the supply pipes are old and leaking and cross-contaminations cannot be excluded. A Water Quality Analysis Report is presented in the document prepared by seureca and NETWAS Tanzania Ltd (2011).

Figure 3 Borehole at police station in close vicinity to an unsealed septic tank.

Figure 4: Private shallow well.

Due to various reasons, the central water supply network does not meet fully the demand. Thus almost every property has its private shallow well next to the house which is either the main source of water or an additional supply. Exact figures are unknown, but a good number of people use groundwater as drinking water, often uncooked. Generally the quality of the groundwater, except from the boreholes operated by KYUWSA, is not analysed. The high number of shallow wells, pit latrines and (septic) tanks make an area-wide quality control very difficult. Thus the biggest contamination risk is due to the very high groundwater level and the use of unprotected shallow wells situated next to unsealed pit latrines and (septic) tanks.

The shallow wells have a very high significance in Kyela town. Most of the wells are simple holes in the ground, some are very basically protected (Figure 4). They are generally covered or even protected with an elevated concrete structure. Some are equipped with an electrical pump connected to a private elevated water tank.

4.1.3 Water supply network

The water from the two boreholes is pumped to elevated concrete tanks, where the tank at the police station has the capacity of about 225m³ and the one at the hospital stores 90m³. Both tanks supply the water network by gravity. The water from Kanga Group Scheme is transported by gravity to Ipinda, where it passes a pressure tank and flows to Kyela town. The gravity line is directly connected to the distribution line in Kyela Town.

KYUWSA operates five elevated concrete water tanks (Table 5), constructed in the 1970s and the newest in 1992. Three tanks used to receive water from Kanga Group Scheme, but are currently not in use. The boreholes have both water tanks, in their near vicinity. The water supply network within the town is 16km long. It is a patchwork of extensions facing diverse problems like old pipes with frequent damages, insufficient and different pipe diameters (from 2" up to 8"), leaking pipes and fittings, etc.

Table 5: Capacity of water storage tanks.

Location	Capacity (m³)	Status
Police station	225	In use
Hospital	90	In use
Kalumbulu	22	Not working
Ipiana	90	Not working
Itunge	100	Not working

The supply network in general comprises of three zones (Table 6), which are independent schemes. A plan of the distribution network is attached in → Annex 7.4.

Table 6: Water supply zones in Kyela Township.

Kyela zone	Areas supplied	Sources
A	Northern areas	Boreholes and Kanga Group
B	Southern areas	Boreholes
C	Ipinda	Kanga Group

The reliability of the water supply network depends strongly on the availability of electricity. The boreholes are not equipped with generators. Especially during the dry season, the water frequently gets rationed. Thus, most commercial customers have intermediate water tanks.

The supply rate of the water network is not exactly known. Schimanowski, D. (2011) calculated two different scenarios, which results in a 13% or 33% service coverage depending on the method used. The main difference is if the calculation is based on the average household size of 4,9 or if assumed that more than one household is using a customer connection and one person consumes 70l per day. But due to flat rates and only few metered customers, any calculations are rough estimations. However, the network supplies about 2,600 customers (by October 2011), 68 public taps, as well as most commercial and institutional buildings. None of the public water taps are currently in operation, due to the lack of need. It is a common practise that people collect water from their flat rated neighbours. The need may change, if all customers are metered.

KYUWSA has two main different categories of water prices, for metered water per m³ and flat rates per month, further differentiated into four categories: (1) domestic, which are private households, (2) commercial, mainly hotels, guest houses, restaurants or any other kind of business, (3) institutions, comprising of schools, churches and offices, and finally (4) industry, but there is no industry in Kyela. Table 7 provides an overview of the different water prices.

Table 7: Water prices from water supply network.

	Metered water (per m³)	Flat rate (per month)
Domestic	300 TSh	4,500 TSh
Commercial	390 TSh	9,500 TSh
Institutions	335 TSh	10,000 TSh
Industry	500 TSh	13,000 TSh

Out of the currently 2,600 customers, only 600 are equipped with water meters, these are mainly commercial and institutions. The majority of customers still pay monthly flat rates, but further metering is in process. A data base of all customers was recently finished and has improved the billing system. However, one main problem KYUWSA is facing are unpaid water bills. Nearly 50% of the

costumers are not paying their water bills and about a quarter of customers (700 out of 2600) already have been disconnected from the supply network.

As Kyela is a fast-growing town, the amount of customers is constantly increasing. Especially during dry seasons people are applying for a water connection, which costs a 17,000 TSh connection fee, plus material and labour. Additionally, every new customer has to buy a water meter for 60,000 TSh from KYUWSA.

4.1.4 Financial considerations

According to Mr. Abu the main income generated by KYUWSA are water fees paid by their customers. The expected income per month is 12 million TSh, but only 6 million TSh are generated at the moment, mostly due to unpaid water bills. With the generated income KYUWSA is able to cover their running costs but funds are lacking for further developments like the purchase of skilled personnel, extension of the network, rehabilitations, etc.

In the Study Report of Kyela Town (seureca and NETWAS Tanzania Ltd, 2011) it is mentioned that "both domestic and non-domestic consumers in Kyela Town did not have a problem to pay for improved services since they know the consequences of using shallow wells. People suffer a lot during the rainy seasons because their pit latrines flood and infect the wells."

4.1.5 Private sector involvement

Currently the private sector is not involved in the water supply of Kyela town. Private water sale through vendors is not a viable business, because of the free and easy access to groundwater through shallow wells. To outsource the operation of public water taps may be a possibility in future, but becomes relevant only after metering all customers discouraging neighbourhood sales.

4.1.6 Recommendations

- **Ensure a sustainable protection of the groundwater.**
- **Provide water in sufficient quantity and quality.**

The sustainable protection of any kind of water source is of main importance. Priorities for the near future and possible strategies may be:

- Awareness creation and education of Kyela's population, for example via Kyela Radio Station and schools.
- Sealing, at least the pit latrines, conservancy and septic tanks in the near vicinity of the boreholes and any other water source, to reduce the risk of cross-contamination.
- The construction of any new connection to the water supply network should be dependant of the availability of an improved toilet facility.
- Establish protection areas around water sources, at least directly around the boreholes to avoid direct contamination (within a radius of 5 – 20m). The establishment of a wider protection area is recommended, which includes a restrictive use within a radius of 60m (depending on the permeability of the soil).

Additionally, KYUWSA is currently in the process of securing funds from the Water Sector Development Programme to extend the distribution of piped water in Kyela town. That may include new boreholes, rehabilitation of the old concrete water tanks and the construction of new ones and an extension of the distribution network. In order to reduce the risk of any contamination, especially with E. Coli, the boreholes will be in the northern, unsettled part of the town, near the road to Ipinda.

- **Reduce the amount of unaccounted for water.**

A rehabilitation of the water distribution network, including supply pipes from the Kanga Group Scheme would improve the situation dramatically. Currently the capital costs exceed the budget available, but a rehabilitation, at least in small patches, is unavoidable. A conceptual design for an

improvement and extension of the water supply network in a mid- and long-term perspective is provided by seureca and NETWAS Tanzania Ltd. (2011).

➢ **Increase the income of KYUWSA.**

Income must be further increased, possibilities may-be:

- All customers of KYUWSA have to install water meters. Mr. Abu even calls that the main priority. This shall go hand in hand with the education of customers on the importance of having meters and paying according to their consumption.
- Increasing the amount of water bills paid from currently 50 up to 100%.
- Upgrading the existing water distribution network and extension to the newly developed areas depending on the water demand of the area. A proposed extension of the network is provided by seureca and NETWAS Tanzania Ltd. (2011).
- Customers sensitisation by awareness creation campaigns in order to encourage payments of the water services.

➢ **Strengthen the institutional capacity of KYUWSA**

KYUWSA has to improve its capacity to provide adequate water supply and sanitation services, this includes among others, an increase of financial and human resources. Detailed recommendations are described by seureca and NETWAS Tanzania Ltd. (2011).

4.2 Human excreta and greywater

4.2.1 Institutional set-up and legal framework

According to the Water Supply and Sanitation Act (2009), the local Authorities are responsible for Water Supply AND Sanitation. But it leaves a lot of room for interpretations as far as sanitation is concerned. Many Authorities still consider sanitation as sewerage only, as it was in their responsibility before the amendment of the new Act in 2009. Also KYUWSA has not yet taken over this responsibility. As there is no sewerage system, the Township Authority still handles all sanitation issues, under the Public Health Department.

The legal framework for human excreta, wastewater and greywater management is formed by:

- Water Supply and Sanitation Act, 2009.
- The Public Health Act, 2009.
- The National Sanitation and Hygiene Policy, Zero Draft, 2009.
- Integrated Implementation of Sanitation and Hygiene, Memorandum of Understanding, 2010.
- Kyela Town Authority (Solid Waste Management) By-Law, 2010.

The Kyela Town Authority Solid Waste Management By-Law (2010), enacted in January 2011, comprises the following paragraphs regarding human excreta and waste water management:

Kyela Town Authority (Solid Waste Management) By-Law, 2010

[...]

§ 18. No person shall allow the escape of or direct or suffer to direct waste water, effluent sludge, night soil, sewage to flow into and compound, sanitary lane street or path.

(1) The cesspit emptying charges shall be paid to the Authority or the agent before the cesspit soakage pit or any other pits overflow and contaminate the environment.

(2) No person shall urinate or defecate in streets or structures other than public or private toilets.

§ 19. The Authority may require the owner or occupier of any premises to make such arrangement for the removal and disposal of waste water and night soil as it may think fit.

[...]

These paragraphs are formulated very general. The amendment of the by-law should be part of a sanitation strategy development, aiming to reach a common vision.

4.2.2 Household sanitation

The majority of people in Kyela town have a private toilet. More detailed data is unfortunately not available. According to the District Health Office about 96% own toilets. The most commonly used facilities are traditional pit latrines (Figure 5) and a small share of (mainly pour) flush toilets. Pit latrines are usually situated outside the house, often without a slab and made of local materials like local burnt bricks or wood. The standards of the latrines vary, from very simple construction to nicely built VIPs. Some people still practise open defecation, but it was emphasised that this is only by the minority.

Figure 5: Pit latrine at household level.

Flush toilets are normally connected to an unsealed (septic) tank or a soakage pit. The tanks are in most cases not water tight holes in the ground and only covered with a concrete slab or local bricks, which are often elevated above ground to avoid rainwater entering.

As the groundwater table is very high, pits and tanks are normally not very deep, it must be assumed that a high proportion of faecal sludge infiltrates into the soil and directly contaminates the groundwater. Certainly during the rainy season it is one of the main problems within the town.

According to Mr. Erasto Mbunga, the Township Health Officer, one of the duties of the Health Department is regular house to house inspections, in order to control if the toilet facility has been constructed according to the required standards described in the National Sanitation and Hygiene Policy, Zero Draft, 2009 (compare chapter 5.2).

Greywater is generated mainly from bathing, washing kitchen utensils and clothes as well as house cleaning. Daily life in Kyela takes place mostly outside the houses. Thus, most of the greywater is already produced in the yards and soaks away directly at the source. If it occurs inside, it is mainly poured on the open ground outside the house. A minority of households collect greywater in (septic) tanks only if they have bathrooms in the houses.

4.2.3 Institutional level, public infrastructure

The Township Authority as well as the District Council are both equipped with flush and pour flush toilets respectively, connected to (septic) tanks. A similar situation can be found in the guest-houses spread over the town. Restaurants, small eating and drinking places have either flush or pour flush toilets with a (septic) tank, but most places use pit latrines or VIPs.

Kyela Township Authority operats the only abattoir (Figure 6) in town. Mainly cows and goats are slaughtered there. All wastewater, including blood and grease, is collected in an unsealed underground tank.

Figure 6: The slaughter house and the unsealed tank for wastewater.

The 4 primary and 10 secondary schools within Kyela Township are lacking both a reliable water supply as well as improved toilets. Most schools have simple pit latrines (Figure 7), mainly too few in number with a very high ratio of users per toilet. According to MKUKUTA (2009) an average of 60 students are using one toilet or latrine in Tanzania, far away form the target of 20 girls and 25 boys.

Figure 7: Pit latrines for a secondary school, one for girls and one for boys.

4.2.4 Public toilets

Kyela Township has four public toilets: One at the main market in CBS (Figure 8), another one at the bus terminal, a third one at the main milling place and a fourth next to the Township Authority at a small market. All of them are operated privately. The toilets are permanently supervised and frequently cleaned. The fee amounts generally to 100 TSh per user.

The toilets are organized in blocks, separated for women and men. All of them are constructed based on the same system: Concrete slabs covered or uncovered with tiles, a ceramic squatting pan and water has to be poured by hand for flushing. The individual toilets are connected to watertight (septic) tanks, which are covered with concrete. The toilets are further equipped with hand washing facilities and with showers.

Figure 8: Public toilet at the main market.

4.2.5 Emptying of pits and septic tanks, reuse and disposal of the sludge

Kyela Township has no public sewer, meaning that everybody rely to on-site sanitation and the emptying of the respective facilities.

Households generally do not empty their pits. When the pit fills a new one is constructed next to it. Using faecal sludge from pit latrines as agricultural fertiliser is not a common practise on household level.

One of the main challenges Kyela Township faces is the lack of a vacuum truck and that no proper dumping / treatment site exists. Currently a pumping truck comes from Mbeya City Council, which is very expensive. According to information from the Township Authority, the vacuum truck costs 10,000 TSh per km, leading up to 2,4 million TSh (120km *10,000*2) and additionally 60,000 TSh per trip in town. The truck is hired at least two times per year, favourably during the dry season. The Township Authority has been announcing the availability of the truck for individual use and people may rent it.

The Township has no wastewater treatment facility, nor a specific place to treat and dump sludge from (septic) tank emptying. Currently the vacuum truck pours the sludge onto the paddy rice fields of farmers within the Township agricultural area during dry season. As the sludge is free, farmers are eager to get the material to fertilize their plantations. According to information from KYUWSA, nearly all faecal sludge is used in agriculture.

However, the current situation is more than unsatisfying. The Kyela Township Authority has planned to construct a wastewater treatment plant. The area for the plant has already been assigned in the Kyela Township Interim Landuse Plan, 2008 - 2018 (→ Annex 7.3). The planned area (Figure 9) is situated on the northern periphery of the Township, surrounded by farmland and next to the road to Ipinda about three kilometres off the main Kyela road. As the whole northern part of the town is swampy during rainy season, it is mainly used for paddy rice farming and completely uninhabited. Thus the planned treatment plant will not interfere with future homesteads.

Figure 9: Proposed area for dump site and wastewater treatment plant.

Apart of determining the site and the type (oxidation ponds) no further plans for the treatment plant exist. For the Town Council the plant has a very high priority, but they lack know-how and the financial resources to plan, construct and manage such a facility. For planning, there may be the support from the Mbeya Regional Secretariat (through GIZ “development worker”), but dependent on the type of treatment facility in question. For an appropriate design, it is worth to engage a professional planner who is able to work on a tailor made solution and not only copy and paste planes from other towns. Currently the property is still in private ownership and the Township Authority has not yet started to negotiate about the availability and the price.

4.2.6 Financial considerations

In the current financial year 2011/2012 (up to the end of June 2012), Kyela Township has an available budget of around 267 million TSh. A total of 47,350,000 TSh are reserved for sanitation expenditures (Table 8 and Table 9) under the Township Health Department, which are nearly 20% of the total budget.

Table 8: Expected recurrent expenditures (financial year 2011/2012).

Recurrent Expenditures	in TSh
Refuse collection	30,900,000
Rent of vacuum truck	1,400,000
Cleaning of drainages	2,700,000
Purchase of public waste bins	2,000,000
Protection gear for workers and small equipment	150,000
Operation of cemetery	1,400,000
TOTAL	**38,550,000**

Table 9: Expected variable expenditures (financial year 2011/2012).

Variable Expenditures	in TSh
Compensation of land and land survey for new solid waste dump site	6,000,000
Construction of 7 solid waste refuse bays	2,800,000
TOTAL	**8,800,000**

Revenues on the other hand are very limited, mainly generated by fees for solid waste collection. In the financial year 2010/2011 it was about 26 million TSh (Table 10).

Table 10: Income generated from sanitation (financial year 2010/2011).

Income	in TSh
Solid waste collection fees	26,000,000
TOTAL	**26,000,000**

The sanitation budget is far from cost-covering, the expenses are higher than the generated income. However, the Township Authority is currently in the process of extending solid waste collection, which will increase the generated income. Any cross - subsidisation from water supply revenues may be a possibility in the future, but KYUWSA is currently only handling water supply and lacks money for any important rehabilitations and developments.

Further financial considerations and partnerships respectively are discussed in → Chapter 5.1.2.

4.2.7 Private sector involvement

The private sector is currently not involved in human excreta, wastewater and greywater management. Latrine pits are not emptied, only (septic) tanks with a vacuum truck coming from Mbeya, rented from the Mbeya City Council.

Depending on future developments, responsibilities for operation and maintenance of sanitation systems may be outsourced to the private sector. That may include specifically emptying and

transportation services for sludge from septic tank, conservancy tanks or faeces and urine (separately) from urine diverting dry toilets (UDDTs). The private sector can also play an important role in demand creation, for example with innovative marketing campaigns.

4.2.8 The link to agriculture

Experience has shown that one of the main obstacles to compost production on a commercial level is the lack of customers. The consultant assumes that the linkage of human excreta management with agriculture, in terms of co-composting[5], has a very high potential in Kyela Township based on the fact that Kyela's main economic activities are in the agricultural sector.

Currently, faecal sludge from (septic) tanks is used as fertiliser in paddy rice farming, but it seems not to be common practice to use human excreta in agriculture according to Mr. Marco Njau, the District Agricultural and Livestock Development Officer (DALDO). Fertiliser, either artificial or organic, doesn't have a high relevance for local farmers. Most of them believe that their fields are fertile enough. However, the DALDO is enforcing the use of fertilisers (both artificial and organic) to replenish nutrients consumed in the intensive agriculture activities and because yields are fare below the regional average.

Regarding the use of human excreta in agriculture, the farmers as well as the DALDO seems to have no reservations. Mr. Njau even offered to use their knowledge transfer system if any developments in that direction are made.

One of the main employers within Kyela region is Biolands International Ldt., a Tanzanian company involved in organic cocoa trade. As Biolands is exporting to Europe, they have to follow the respective EU Regulation on Organic Farming, which does not consider human excreta as fertilizer. However, the consultant still assumes this example is worth mentioning, because there are more companies active in Kyela region, which may have an interest in future cooperation and which do not have to follow the very strict EU organic farming rules.

4.2.9 Recommendations

The problems related to human excreta and wastewater management are very relevant to the Township Authority, especially due to the fact that the groundwater is the main water source. The Authority is in the process of improving the current situation, but is faced with a lack of financial resources as well as know-how and human capacity. Further recommendations are described in → Chapter 5 and → Chapter 6.

- **Ensure a sustainable protection of the groundwater.**
- **Avoid any cross-contaminations from pit latrines and (septic) tanks.**

Currently the Township Authority has no strategy for improving the sanitation situation within Kyela. Bits and pieces are implemented but without a clear vision. In order to streamline any activities, the development of an overall sanitation strategy with mid and long term goals is recommended. One inevitable improvement will be the sealing of pit latrines, VIPs and (septic) tanks. That may take some time, but at least newly constructed facilities have to correspond with a certain standard. To support the transformation, the Township Authority may provide construction plans for improved toilet facilities.

Awareness creation and education should always go hand in hand with infrastructural improvements. Possibilities are via Kyela Radio Station, social marketing, dramas or flyers and posters. Another effective and sustainable way is a school campaign on sanitation and hygiene behaviour. Schools can also provide an entry point to the community, because children take back to their families what they have learned.

Generally, Kyela region profits from cash crop production, thus the general population in Kyela Township can afford a relatively comfortable living standard. They are not the poorest of the poor.

[5]Co-composting means composting of human excreta and / or dewatered sludge and organic waste.

Starting a participatory planning approach will increase the willingness to pay for sanitation improvement among the local population.

Another possible step can be that any new connection to the water supply network is dependant on the availability of an improved toilet facility. If that is not the case, the application for a new connection should be refused by KYUWSA.

➢ **Ensure emptying, transport and treatment of faecal sludge and human excreta respectively.**

In Kyela Township no sanitation system is in place, meaning that after collection through toilet facilities, further processing steps are missing. A first pre-selection of sanitation options is described in → Chapter 5.

However, any improvements in sanitation are a combination of hardware (technical) and software (non technical) components, considering O&M and financial implications.

➢ **Strengthen institutions responsible for sanitation**

KYUWSA and the Kyela Township Health Department, which are the two institutions responsible for sanitation in Kyela Town, need to be strengthened. First of all this implies an increase of financial and human resources.

4.3 Storm water drainage

4.3.1 Institutional set-up and legal framework

The maintenance of drainage systems, especially any cleaning activities, is under the Kyela Township Authority, Public Health Department. The construction of new drainages on the other hand is still under the Kyela District Council. The overall legal framework for storm water drainage can be found in the Public Health Act (2009). However, the Kyela Town Authority Solid Waste Management By-Law, 2010 does not specify storm water drainage any further.

4.3.2 Open drainage system

The groundwater table in Kyela Township is very high throughout the year. In some places it even reaches the surface level during dry season. As the mean annual rainfall in the area is very high (between 2000 and 3000mm per year) and the topography of Kyela Township is nearly flat, large parts of the town get flooded during heavy rainfalls. Some parts, like the bus terminal are nearly inaccessible, because rainwater stays stagnant on the unpaved, compacted areas.

Within CBD and the planned areas of the town, the main storm water channels drain the rainwater out of town. These channels are mainly unpaved and follow the main roads. The major drainage channel (Figure 10) is going from East to West through the CBD leading into a small river, which drains into Lake Nyasa. Three more drainage channels are planned. All three shall be constructed more or less parallel to the main one. Additionally it is planned to rehabilitate the old Kyela river, which should drain the western part of the town. Due to the urgency of the problem, the planning of these channels is already in progress but the Township Authority is still waiting for finances from the District Council.

Figure 10: Main drainage channel within the town centre.

The drainage channels are maintained by the Township Authority and are cleaned regularly, at least before rainy season. Any littering as well as waste water or greywater intake is prohibited and executed accordingly. In practice, the channels are misused for littering. This problem should be reduced by the improvement of the solid waste collection system, which is currently in progress.

For the remaining unplanned and peri-urban areas some minor drainage channels exist (Figure 11). They either drain to several unplanned ponds, which store water run-off up to a certain extent during peak rainfalls. These ponds have almost no planned run-off and rely mainly on evaporation. This causes the water to remain in the ponds for months and are ideal mosquito breeding grounds. Some other channels might drain to the wetlands in the East or into Kiwira river in the West.

Figure 11: Drainage channel full of stagnant water one day after rainfall.

4.3.3 Financial considerations

As the maintenance of the drainage channels is under the Township Authority, it is considered in their budget. For the current financial year 2011/2012, 2.7 million TSh have been budgeted including mainly cleaning activities.

For the construction of new drainages, the Kyela District Authority is responsible. Thus the latter has to budget for any activities, but it is also possible to receive further funds from the Cross Boundary Nyasa Basin Fund. Planning and construction is done within the Authority and Council respectively.

4.3.4 Recommendations

- **Development of an efficient storm water drainage system.**
- **Ensure a drainage system free of any pollutants, like solid waste, human excreta, waste water or any hazardous substances.**

Storm water drainage is one of the main challenges facing Kyela Township. Already after the first rainfalls, at the beginning of the rainy season (in November), some areas have stagnant water ponds. During the peak rainfalls, parts of the town are inaccessible.

The urgent need of an improved drainage system is obvious. First investigations to improve the current situation are underway. It is generally recommended that the local infiltration of relatively uncontaminated rainfall run-off should be encouraged. This implies that the drainage network is exclusively for rainwater and must be kept free from any contamination with human excreta, waste water, hazardous liquids or any kind of refuse.

Further recommendations are described in → Chapter 5.3.6 Storm water drainage.

4.4 Solid waste management

4.4.1 Institutional set-up and legal framework

The responsibility for solid waste management is with Kyela Township Authority, Health Department. The Kyela Town Authority (Solid Waste Management) By-Law, 2010, defines clearly the responsibilities of refuse collection:

Kyela Town Authority (Solid Waste Management) By-Law, 2010

[...]

§ 10. The Authority shall arrange for disposal of trade and domestic refuse collected respectively from trade premises and residential houses, and shall collect and dispose off those refuse as specified by the Authority.

[...]

§ 16 The Authority may appoint any person, company, Association, Community Based Organization or any other Body Corporate to act as its agent in rendering such service, in doing so the appointed agent shall be responsible for collection and removal of all wastes in the prescribed area and maintain the same in the manner required by the Authority.

[...]

Since 2008, solid waste collection is outsourced in order to hand over the responsibility to a private operator. According to Mr. Oswald Mwakalasi, the Township Executive Officer, the collection is tendered again every year in May. The private operator is paid on a lump sum basis to collect solid waste from CBD and neighbouring areas.

The refuse collection charges rates are defined in the respective By-Law. At the moment only commercial facilities like shops, restaurants, guest houses etc. have to pay collection fees. These charges are collected by the Township Authority. For households the collection service is still for free, but anyhow only offered in CBD.

4.4.2 Amount and characteristics of solid waste

Neither the amount nor the characteristics of solid waste are known. But it is guessed that the share of organic waste is about 60-80% of the municipal waste. The remaining 20-40% are mainly plastics like

thin PE bags or any other plastic wrapping material which are found next to roads or blown away from the wind throughout the town.

The District Hospital in town additionally produces hazardous and infectious wastes, comprising mainly of old bandages, syringes and needles, infusions and latex gloves. These wastes are currently dumped on the hospital ground and burned occasionally. It is assumed that this practise contaminates the high groundwater table and is highly dangerous. According to Mr. Mbunga, the Town Health Officer, a medical waste incinerator is under construction.

Figure 12: Dustbin in CBD.

Kyela Township has two permanent markets which are "hot spots" of waste production. Since the enactment of the Kyela Town Authority Solid Waste Management By-Law, 2010, the Township Authority provides dustbins in the market area and CBD (Figure 12), where all types of solid wastes are collected.

Small scale industry in Kyela consists mainly of food processing (maize / rice mills and palm oil production), soap production and welding factories, garages and petrol stations, an abattoir as well as carpentries. Some of them may produce hazardous wastes (like oil cans or paint residues), which are neither separated from solid waste nor disposed of properly.

4.4.3 Collection, disposal and recycling

Solid waste collection is outsourced to a private operator. However, it is still in the responsibility of the Township Authority, which is currently extending the collection. Waste bins are provided along the main roads and people are encouraged to throw their waste into them. For the moment, this service is offered for free, but shall be charged in future. Nevertheless, most of the refuse especially from households is still not collected.

Figure 13: Currently used unprotected dumping site in Kyela Township.

The refuse collected is transported with a truck to an unprotected dump site in the West of Kyela Township (Figure 13). This area is situated between agricultural land of permanent crops in a former quarry for sand. The waste is occasionally burned in order to reduce the volume. Especially the smoke poses a health risk to farmers and their children whose houses and fields are just next to the landfill.

As the dumping site is not fenced, access is not restricted. Open dumping is furthermore a source of groundwater pollution and it can be assumed that also hazardous substances get infiltrated.

Households, restaurants, guest houses, enterprises, etc. outside of CBD have no collection service in place. The ones with animals use waste biomass for livestock feeding. The remaining solid parts are openly dumped outside of the yards or in pits in order to be burnt as soon as sufficient material has been collected.

In Kyela Town no formal recycling of specific waste is taking place nor any kind of waste separation. Only organic waste on household level for livestock feeding and medical waste in the hospital is collected separately. Plastic water bottles are collected additionally, mainly to be reused for other purposes.

4.4.4 Financial considerations and involvement of the private sector

Solid waste collection is currently the only income generator in the sanitation sector of Kyela Township Authority. In the last financial year 2010/2011 about 26 million TSh were collected. A further extension of the collection service should increase that income, but may go hand in hand with an increase of the expenditures of 2 million TSh per month (financial year 2010/2011) for the private operator.

Solid waste collection operates currently more or less cost-covering, but only if the recurrent expenditures are considered. The income does not cover variable expenditures like for the planned new dump site.

Since 2008 a private operator is responsible for solid waste collection. That service is currently restricted to one operator, due to the lack of budget. For the financial year to come (starting with the 1st of July 2012) the Township Authority has planned to tender the Northern and the Southern parts of Kyela Township separately. The private sector can also be involved in recycling activities, for example of plastic waste or production of compost, which are still unexplored markets within Kyela Township and beyond.

4.4.5 Recommendations

➢ **Development of an efficient solid waste management service.**

In future, waste generation will steadily rise and simultaneously the share of inorganic waste. The waste collection system in Kyela town is promising but needs further development. The waste management concept should be based on two concepts:

- Reduce, reuse, recycle – this should be the heart of any waste minimization strategy. The aim is to extract the maximum practical benefits from products (reuse and recycle) and to generate the minimum amount of waste (reduce).
- Polluter-pays-principle - is a principle where the polluter pays for the damage the waste costs the environment and for the disposal of the waste produced.

This implies that a focus has to be on waste reduction in general, the extension of collection services, strengthening any separation and recycling activities. Waste management is an income-generating activity. Possibilities are to promote composting activities, which can be done on household as well as on municipal level, to encourage recycling, particularly paper and plastics or the prohibition of plastic bags and to encourage the use of paper bags instead or from other locally made materials.

Whatever actions and improvements are decided upon, they should be based on a participatory planning approach. People are at the heart of the waste management problem. They generate waste and without their active cooperation and participation it is not possible to implement a sustainable waste management system. For example, before starting to construct refuse bays, ask the users for their needs and suggestions.

Absolutely essential is a continuous public education program, which has to be integral part of the solid waste management concept.

➢ **Ensure a sustainable disposal of solid waste.**

The Town Council is constantly improving the current situation. According to Mr. Mwakalasi (Town Executive Officer) and Mr. Mbunga (Town Health Officer), it is planned to improve and extend the solid waste collection system, to construct solid waste collection points (refuse bays) and to construct an appropriate landfill. Before starting any construction activities, the consultant recommends to strengthen a participatory approach and to invest in an appropriate planning according to the state-of-the-art.

5 LOW-COST SANITATION CONCEPT FOR KYELA TOWN

5.1 Sanitation approaches

5.1.1 System approach

The concepts suggested by the consultant are not based on single technologies, rather on a system approach. A sanitation system is considered a multi-step process where products are managed from the point of generation to the point of re-use. Hence a sanitation system comprises five process steps, involving a number of technologies, which have to be selected according to the local situation. By combining suitable technologies from each different processing step, one can design an appropriate sanitation system. The Compendium of Sanitation Systems and Technologies (Tilly et al., 2008)[6] may be a useful planning and reference tool and is recommended by the consultant.

The five processing steps for a sanitation system are:

1. **User interface** includes an appropriate toilet, a bathroom and a hand washing facility. The choice of the user interface influences the affiliated technologies.
2. **Collection / storage** describes the different possibilities to collect and store the products that are generated at the user interface.
3. **Emptying / transport** describes the mode of transport from one process step to the other.
4. **Treatment** includes a variety of technologies which are more or less suitable for a certain context. A detailed analysis to find the best solution is worthwhile.
5. **Use / disposal** refers to the method in which products are ultimately returned to the environment, either as valuable resources for use or disposal where there is no need for them.

A sanitation system also includes specific operation and maintenance, as well as management procedures to ensure that the system functions safely and sustainably. The question "Who operates?" must go hand in hand with any technological decisions. For example, the addition of pumps and other technical devices will increase the need for regular skilled maintenance and parts replacement. The responsibilities for O&M for different system components may be assigned to different stakeholders. For instance, maintenance of the toilet is mostly in the responsibility of the household, emptying and transport services are covered by the private sector, while a central wastewater treatment plant is operated by the water companies or the township authorities. Clear delineation of O&M tasks and responsibilities as well as partnerships between households, water companies, NGOs and service providers is critical for achieving a sustainable system.

Sanitation systems can further be distinguished between (i) dry or waterless and (ii) wet or water dependent in regard to the transport of excreta. Weather a sanitation system is wet or dry depends mainly on the user interface. If water used for flushing, wastewater is produced, which has to be treated accordingly. If the type of toilet is waterless, like pit latrines, VIPs or urine diverting dry toilets, the system is dry and the collected human excreta has to be treated in a different way.

[6] Link to download: http://www.eawag.ch/forschung/sandec/publikationen/sesp/dl/compendium_1_32.pdf

5.1.2 Financial partnerships

The improvement of the sanitation situation always needs financial investments. Depending on the system, these costs may be low or high, but a certain amount of money is always needed. If the sanitation system is to meet national standards, for example quality standards for wastewater treatment as referred to in the Public Health Act (2009), it can never be a low cost solution. Centralised treatment plants are expensive, independent of the technology chosen.

Generally there is a will to improve the situation. But options proposed must be financially affordable, especially for the households, since they bear the main costs for any improvements. Including the users in sanitation planning will increase the sustainability and the willingness to pay of any sanitation system.

Apart from financing of infrastructure (hardware), software components also have to be considered. Experiences have shown that hardware alone is not sufficient! Thus improvements in sanitation always consist of a hardware and a software component. The hardware covers the construction of sanitation infrastructure necessary to setup sanitation systems. The software includes sanitation services, like the collection of solid waste or the emptying of septic tanks (mainly operation and maintenance activities), and awareness raising and capacity building measurements, with focus on health and hygiene education. For a sustainable sanitation system, the combination of hardware and software must go hand in hand.

The rapid needs assessment has shown that it is very unlikely that Kyela Township is able to pay for the capital costs of an integrated infrastructure upgrading scheme alone. Without additional revenues it will be almost impossible to achieve full cost recovery and thus sustainability of these new services. However, different options for financing sanitation in Kyela Township deserve exploration:

- **Own resources** cover the available budget composed from the Township Authority and the District Council. For every financial year the budget will be renegotiated. For bigger investments an increase of the share for sanitation is inevitable, going hand in hand with a middle- and long-term planning. Furthermore, own resources also cover income from any sanitation activities, which are currently solid waste collection fees only. More income should be generated for example to enhance solid waste collection fees, or other charges such as for wastewater, etc. Generally it can be assumed that the potential to generate own resources is high, in view of the fact that Kyela´s economy is thriving.
- **Outsourcing of public services** has already started in Kyela Township. For solid waste collection a private operator is responsible. The Authority has already planned to extend that service within the coming financial year 2012/2013. But also for other sanitation services outsourcing is a viable option. Different steps of a sanitation system can be operated by the private sector but are monitored by higher level institutions. For example a school sanitation system may be operated by the school management, but monitored by the Health Department. Other possibilities are the emptying of septic and sludge holding tanks by licensed private operators or the emptying service for UDDTs. The production of compost is another option which can make use of biodegradable waste, dewatered sludge and separately collected faeces and urine.
- **External resources** are mainly funds received from private or public donors. That includes project financing via targeted government funds like the WSDP or other donors like the African Development Bank, the Bill and Belinda Gates Foundation, GIZ, etc.
- **Capital financing by users,** contributions either in cash or in kind (like labour or material), mainly at the household level for toilet construction.
- **Public subsidising** of sanitation infrastructure is a very efficient instrument like the Water Service Trust Fund in Kenya (http://www.wstfkenya.org). Unfortunately such an instrument does not exist in Tanzania at the moment, but may be available in the future.
- **Public private partnerships** (PPPs) are long-term partnerships between the public (Kyela Township Authority) and the private sector (SMEs, NGOs, CBOs, etc). PPPs may include financing, design, construction, operation and maintenance or any other kind of services.

However, public private partnerships are a lengthy process and need a proper preparation. A possibility can be a cooperation between the Township Authority and Biolands International Ldt. in terms of an awareness raising campaign on health issues or the construction and management of public toilets.

It can be anticipated that a combination of different financing mechanisms is necessary for sanitation infrastructure upgrading. An additional difficulty is securing adequate O&M financing. That is only possible if recurrent costs are covered by the users themselves, meaning that they are willing and able to pay O&M costs.

5.2 Minimum standard and service level

Within the framework of this study, the consultant has been asked to recommend suitable sanitation systems for Kyela Township. To compile respective sanitation systems it is important to establish a minimum standard for various technologies and a minimum service level for the safe use / disposal of human excreta, sludge or effluent. In the context of this study the minimum standard refers to the sanitation facility and the design criteria applied (e.g. latrines with a slab). The minimum service level refers to services provided by the Township Authority, KYUWSA, the private sector, etc. related to emptying, transport, treatment, use or disposal.

The National Sanitation and Hygiene Policy, Zero Draft, 2009 clearly differentiates between improved and unimproved sanitation facilities, considering only the type of toilet.

The National Sanitation and Hygiene Policy, Zero Draft, 2009

Improved sanitation refers to facilities that ensure hygienic separation of human excreta from human contact:

- Flush or pour-flush toilet to piped sewer system, septic tank, pit latrine.
- Ventilated improved pit (VIP) latrine - a dry pit ventilated by a pipe that extends above the latrine roof. The end of the vent pipe is covered with gauze mesh or fly-proof netting and the inside of the superstructure is kept dark.
- Pit latrine with slab – is a dry pit latrine which uses a hole in the ground to collect the excreta and a squatting slab or platform that is firmly supported on all sides, easy to clean and raised above the surrounding ground level to prevent surface water from entering the pit. The platform has a squatting hole, or is fitted with a seat.
- Composting toilet - a dry toilet into which carbon-rich material are added to the excreta and special conditions maintained to produce inoffensive compost. A composting latrine may or may not have a urine separation device.

Unimproved sanitation facilities are those which do not ensure hygienic separation of human excreta from human contact:

- Pit latrines without a slab or platform – uses a hole in the ground for excreta collection and does not have a squatting slab, platform or seat. An open pit is a rudimentary hole in the ground where excreta is collected.
- Hanging latrines – is a toilet built over the sea, a river, or other body of water, into which faeces and urine drops directly.
- Bucket latrines – refers to the use of a bucket or other container for the retention of urine and anal cleaning material, which are periodically removed for treatment, disposal or for fertilizer.

For the development of a sanitation concept for Kyela Township it is crucial to define different technology options to be considered as “standard”. These options include a range of technologies from the user interface, collection / storage, emptying / transport, treatment to use / disposal. Regarding the

first three processing steps, individuals and households should be allowed to choose from a range of technological options based on the users´ preferences and willingness to pay. The sanitation concept suggested for Kyela Township is based on a stepwise approach, like a "ladder of service levels" that individuals and the community as such can climb towards safe, affordable and sustainable sanitation.

Within the framework of the WASHCost project[7], a service delivery approach was developed. It takes the entire service delivery into account by combining O&M and technology options. For example, a well operated and maintained VIP is a higher level of service than a badly maintained septic tank or a full flush system with inadequate water supply and wastewater treatment. WASHCost proposes a service ladder of four broad categories or levels: improved service, basic service, limited service, and no/unacceptable service (Potter, A. et al., 2011). These service levels should be assigned separately for human excreta management, for greywater and for solid waste.

For human excreta management Potter, A. et al. (2011) describe two acceptable service levels:

Basic service: At this level all households have reasonable access to at least one safe, relatively robust, private sanitation facility, available hand washing facilities, relatively weak desludging and other long term maintenance provisions, and non problematic environmental impact or safe disposal of sludge. This is typical of most acceptable rural and peri-urban sanitation services.

Improved service: At this level, all users have easy access at all times to a convenient, private, safe, robust sanitation facility which seals against flies and bad odours, has nearby hand washing facilities, where minimal effort is required for desludging and long term maintenance, and there is re-use, safe by-products with non-problematic environmental impacts.

Figure 14 provides a diagrammatic representation of the WASHCost service ladder.

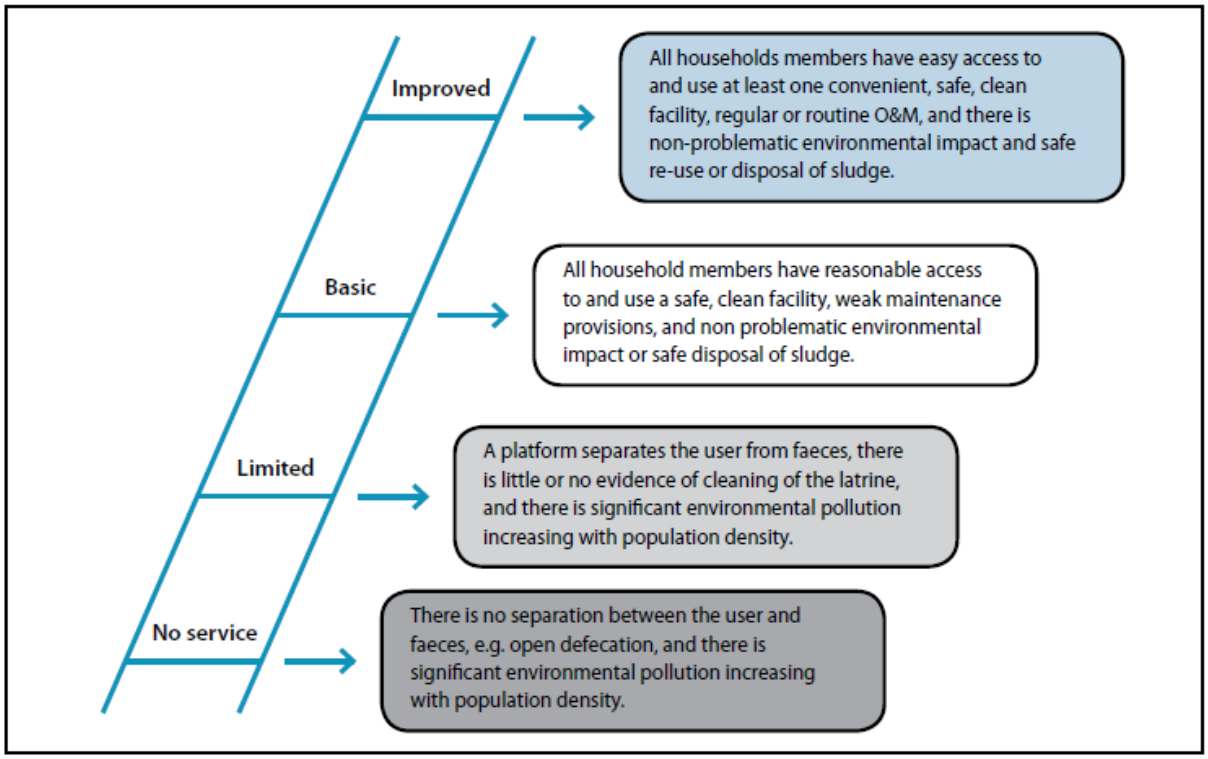

Figure 14: WASHCost Sanitation Service Ladder (Potter, A. et al., 2011).

For analysis where a community stands, the percentage of households at each service level within each service parameter will be recorded so as to provide a comprehensive picture of service levels in a particular area.

[7] http://www.washcost.info/

Table 11: WASHCost Sanitation Service Levels with summarised composite indicators for deciding overall service levels (Potter, A. et al., 2011).

Service levels	Accessibility	Use	Reliability (O&M)	Environmental protection (pollution and density)
Improved service	Each family dwelling has one or more toilets in the compound	Facilities used by all members of the HH	Regular or routine O&M (inc. pit emptying) requiring minimal user effort	Non problematic environmental impact disposal and re-use of safe by-products
Basic service	Latrine with impermeable slab (HH or shared) at national norm distance from HH	Facilities used by some members of the HH	Unreliable O&M (inc. pit emptying) and requiring high user effort	Non problematic environmental impact and safe disposal
Limited 'service'	Platform without (impermeable) slab separated faeces from users	No or insufficient use	No O&M (pit emptying) taking place and the presence of extremely dirty toilets	Significant environmental pollution, heightening with increased population density
No service	No separation between user and faeces, e.g. open defecation			

Depending on the availability of O&M services, environmental protection and proper use, examples of technology options at the various levels could include:

- Limited service: Pit latrine without a slab, hanging latrine, bucket latrine (correspond with the definition of unimproved sanitation facilities by the Ministry of Health and Social Welfare, 2009).
- Basic service: VIP, pit latrine with slab, (pour) flush toilet connected to a septic tank with on-site treatment, etc.
- Improved service: (pour) flush toilet with septic tank and off-site treatment, (pour) flush toilet with (simplified) sewer and (decentralised) wastewater treatment plant, Urine diverting dry toilets, etc.

The basic service defines the minimum standard (for example a pit latrine with slab), which every person in Kyela should have access to. This first step is clearly far from perfect, but is an initial step in the direction of environmental protection and providing health benefits to the people. On the upper rung are the long term objectives, defined by Kyela Township Authority such as a complete treatment of all human excreta and wastewater according to national standards.

5.3 Sanitation concept for Kyela Twonship

The challenge to outline the feasibility for a comprehensive low-cost sanitation approach for Kyela Town is highly versatile. The framework conditions are mainly defined by a flat landscape, a very high groundwater level, an unreliable electricity supply, regular flooding of the town as well as limited financial and human resources. That leads to a situation which is not to be handled by a single technology. Thus, the consultant suggests a variety of technologies which have to be compiled to sanitation systems, consisting of hardware as well as software components.

The consultant points to the fact that the following is only a first pre-selection of possible technologies. The development of appropriate sanitation systems needs a comprehensive sanitation strategy for Kyela Township as a whole, based on a detailed baseline study and a planning process described in chapter 6 respectively.

Along with any infrastructure improvement, awareness building activities need to be designed to prepare the community for the need of improved sanitation services. Simultaneously, the development of an appropriate operation strategy is of utmost importance. Otherwise, any infrastructure

implemented will not work to full capacity and the consequences are poor or non-functioning systems that damage the environment and the peoples´ health. Without proper O&M, well designed and nicely constructed infrastructure will sooner or later break down.

The different systems have in common that a proper wastewater and faecal sludge management is needed. There are different options possible and all have their pros and cons, likely a compromise solution will be chosen. However, the consultant recommends investigating in a detailed study in order to find the best solution and not to follow the common practise to construct wastewater stabilisation ponds without considering other options.

Four different sanitation systems suitable for Kyela Township have been identified:

System 1: Waterless sanitation system with (ventilated) improved pit latrine.

System 2: Waterless sanitation system with urine diverting dry toilet and waterless urinal.

System 3: Pour flush sanitation system connected to (communal) three chamber septic tank.

System 4: (Simplified) sewer with (decentralised) wastewater treatment plant.

The technologies suggested have been pre-selected according to the requirements of improved sanitation service provision for urban areas in Tanzania. The Consultant is aware that the list may not be complete and one may suggest different options.

5.3.1 System 1 – Waterless sanitation system with ventilated improved pit latrine

This option corresponds with the common practise of using pit latrines and the above described basic service level. Although the disadvantages are known, especially the high risk of groundwater contamination, it is the most realistic alternative in a short term perspective. This alternative should be seen as a compromise and a first step to improve the current situation.

User Interface: Following this option, the existing traditional pit latrines must be upgraded to improved pit latrines with slab, ventilation and a hand washing facility. Figure 15 and Figure 16 show examples of properly constructed VIPs in Kisumu and Nakuru.

Figure 15: Ventilated improved pit latrine (Kisumu, Kenya).

Figure 16: VIP and bathroom attached to a private house (Nakuru, Kenya).

Collection / storage: In the more basic version, which does not improve the problem of groundwater pollution, a pit is used to collect and store the excreta. The system can be based on a single or double pit system. In Kyela it is absolutely essential to line the pit, because of the high groundwater table. Design the pit to prevent rainwater to enter the pit, by raising the pit over the ground level for at least 10 cm.

A more improved and environmental friendly version is the connection to a conservancy tank, a sealed holding tank which stores the excreta. Anaerobic processes in the tank reduce the organic and pathogen load, but the effluent is still not suitable for direct use and must be further treated.

Greywater from the bathroom, the hand washing facility, from the kitchen and from cleaning can either be collected in the conservancy tank or a separated treatment is required. The easiest way of getting rid is a simple soak pit in each house. The simplest version is a simple pit filled with coarse rocks and gravel. In general a soak pit should be at least 1.5m above groundwater level (Tilly, et al., 2008). Thus further investigations are needed in Kyela town in which areas this option is suitable.

Emptying / transport: When the conservancy tank is full, the wastewater has to be removed by a vacuum truck or another vehicle equipped with a motorized pump and a storage tank for emptying and transporting wastewater. As the wastewater is highly pathogenic prior to treatment, human contact, direct agricultural applications or dumping must be avoided, thus a proper faecal sludge management is needed. The removed wastewater must be transported to a (wastewater) treatment plant.

Treatment: Different possibilities for treatment exist, for instance a sludge drying bed, a trickling filter or a wastewater stabilisation pond. Details are described in system 3.

Use / disposal: The treatment systems produce effluent and faecal sludge. The treated effluent can be used for irrigation or groundwater recharge. Treated faecal sludge can be used in agriculture as soil conditioner.

Considerations: Pit latrines are generally not suitable for areas that flood frequently and / or have a high groundwater level. In combination with a watertight conservancy tank the situation is upgraded to a high extend.

5.3.2 System 2 – Waterless sanitation system with urine diverting dry toilet and waterless urinal

Urine diverting dry toilets (UDDTs) would be completely new in Kyela Township. If this option is chosen, intensive interactions with the community will be required by starting with a few demonstration units of UDDTs including waterless urinals as well as a hand washing facilities. UDDTs are considered an option, because they are very suitable for the environment in Kyela:

- The risk of groundwater contamination is reduced, because the superstructure is constructed completely above ground. That has the big advantage that the chambers do not overflow during the rainy season and the collection container (faeces) and tank (urine) are not in direct contact with the high groundwater level.
- UDDTs are permanent toilets, where the separately collected urine and faeces are emptied regularly. This type of toilet saves costs in a longer perspective as well as room, because it is not necessary to construct new ones when full (as is common for pit latrines).
- UDDTs can also be built indoors, which is very comfortable.
- Separately collected urine and faeces can easily be transferred to fertiliser, which is attractive for an agricultural dominated region like Kyela.

User Interface: System 2 is waterless and based on a urine diverting dry toilet (Figure 17). The principles of this system are the separation of urine and faeces, the separate storage, treatment and use of human excreta. Further it consists of a waterless urinal. Also important is a constant supply of bulking agent like ash, lime, or dry earth to cover the faeces to minimize odours and provide a barrier between the faeces and potential vectors, like flies. Basic requirements are a watertight dehydration chamber, a ventilation pipe and a provision to separate urine and faeces, by using a special design squatting pan (Figure 18) or toilet seat. A bathroom and a hand washing facility should also be provided.

Collection / storage: Containers (Figure 19) are used to store the faecal material. It is recommended to design the vaults big enough to store at least two containers. Generally, faeces should be kept as dry as possible to encourage dehydration and hygienisation. Urine is collected in closed storage tanks for instance in jerry cans (Figure 20) to be transported for further use.

For greywater a separated treatment is required since it should not be introduced into the dehydration vaults. Greywater shall be treated accordingly; possibilities are soak pits as described in system 1.

Figure 17: Urine diverting dry toilet (Arusha, Tanzania).

Figure 18 Squatting pan for faeces and urine separation (Kalungu, Uganda).

Figure 19: Container for storage of faeces (Arusha, Tanzania).

Figure 20: Urine storage in closed storage tank (Arusha, Tanzania).

Figure 21: Co-composting of faeces and organic waste (Maracha Hospital, Uganda).

Emptying / transport: A UDDT has to be emptied frequently, depending on the number of users. Dried faeces and stored urine can be emptied and transported by human / animal power or by motorized power to further treatment.

Treatment: Co-composting (faeces together with organic waste) is an effective way to produce a hygienically save soil conditioner (Figure 21). Urine does not need any treatment, but for logistic purposes it can be stored centrally in bigger tanks for further use and partly used as further ingredient to the co-composting process.

Use / disposal: Compost is a nutrient rich soil conditioner for agricultural purposes. Urine contains a lot of nitrogen, which is ideal to fertilise nitrogen demanding plants, like maize:

Considerations: By implementing this option, some additional activities are related: (i) a strong awareness raising and training campaign over a longer period, (ii) regular supervision and back up for the users of UDDTs, (iii) the development of a special O&M concept, including an emptying service and (iv) the development of a market for faecal fertiliser and urine.

This system is especially suitable for schools as well as individual households which are willing to change behaviour and are confident of the advantages.

5.3.3 System 3 - Pour flush sanitation system connected to (communal) three chamber septic tank

Currently only a minority of users have pour flush toilets, connected to unsealed (septic) tanks. It is expected that the number will increase constantly in the coming years. For this option it is recommended to strengthen the use of pour flush rather than full flush toilets to minimize the amount of water to be treated in a septic tank. From an environmental point of view, it is recommended to use conservancy tanks which have to be watertight without an overflow. That is especially important under the given framework conditions with the high groundwater table in Kyela. As a consequence, the tanks have to have a holding capacity of about 50l per person per day. Having a family of 5, the capacity for a month would be 7.5m³. Depending on the frequency of emptying, the tanks have to be accordingly bigger. From a financial point of view, this option would become very expensive mainly due to the costs for the vacuum truck. Considering the common practise, it is expected that permeable instead of watertight tanks will be constructed in order to reduce the frequency of emptying.

Be aware that the following suggestion, though it is neither sustainable from an environmental point of view, nor complies with national standards for wastewater treatment, it is still one of the most realistic possibilities.

User Interface: This alternative is composed of pour flush toilets. Water is poured into the bowl by the user to flush the toilet of excreta (app. 1 to 2l is usually sufficient). The toilet consists of a water seal that prevents odours and flies from coming back up the pipe. Greywater from the bathroom, the hand washing facility and from sinks, etc. are also be introduced into the system.

Collection / storage: The pour flush toilets together with the greywater are connected to a household or communal septic tank. The septic tank should have three chambers in order to increase treatment efficiency and be watertight. The partly treated wastewater from the last chamber is connected to a soak pit for on-site infiltration. Particular attention should be paid to the size and place of the tanks to avoid floating due to the high groundwater level.

Emptying / transport: The sludge should be removed annually using a vacuum truck or a tractor with vacuum tank to ensure proper functioning of the septic tank. Access to the location should be guaranteed as well as a proper treatment of the sludge.

Treatment: Under this alternative a proper faecal sludge management needs to be installed. An efficient possibility is a sludge drying bed (Figure 22) including a treatment for leaching water and finally the use of the dried sludge as manure in agriculture. If a conservancy tank is used, another possibility is a trickling filter (Figure 23), with the advantage that smaller land is required and it is more efficient compared to oxidation ponds. The biggest disadvantage is that a continuous supply of power and wastewater is required. A third option is a wastewater stabilisation pond, which is relatively simple to operate, but requires large land area and emptying of sludge is expensive.

Figure 22: Sludge drying bed for a hospital (Kitgum, Uganda).

Use / disposal: For use / disposal of the treated effluent and faecal sludge different possibilities exist. The effluent can be used for irrigation, groundwater recharge, discharge via a percolation trench or water body recharge. Treated faecal sludge can be used in agriculture or disposed via dumping.

Considerations: Additionally it should be considered that communal septic tanks can later be upgraded and, for example, connected to a simplified sewer and a central wastewater treatment plant. This option should be already integrated into planning.

5.3.4 System 4 – (Simplified) sewer with (decentralised) wastewater treatment plant

A sewer network connected to a centralised wastewater treatment plant should be considered in a long-term perspective. It is included because (i) most other systems are not suitable for areas with a high groundwater table, (ii) emptying of the watertight collection tanks become very expensive over a longer period and (iii) Kyela town has theoretically enough water to operate a sewer network. Thus the consultant believes that it is worth to investigate in a feasibility study, especially from a financial point of view. The construction of a sewer network is often cheaper than operating many conservancy and septic tanks in densely populated areas. As it is not possible to construct a gravity sewer in Kyela town, different alternatives should be looked at like the possibility of using solar pumps, a simplified sewer and sewer discharge stations.

User Interface: The sanitation facility used is a pour flush or full flush toilet, which is connected to a sewer. Greywater from the bathroom, the hand washing facility and from sinks, etc. can also be introduced into the system.

Collection / storage: Generally no storage is needed. All wastewater is transported to a treatment plant directly. Depending on the type of sewer, intermediate storage will be necessary. For a sewer with (solar) pumps, it is likely that storage tanks are required.

Emptying / transport: The generated wastewater is transported via a (simplified) sewer to further treatment. Simplified sewers are generally less expensive if the site conditions permit a condominial design. It is assumed that for a gravity sewer the terrain is too flat.

Treatment: As for the other options, a proper treatment of the wastewater needs to be implemented. With the figures available the consultant assumes that a trickling filter (Figure 23) is the most suitable option. But further investigations are necessary.

Additional possibilities are decentralised wastewater treatment systems, where wastewater for a cluster of houses is transported in a sewer network to a treatment facility connected to a constructed wetland

system (Figure 24). That is above all suitable for self-contained institutions like hospitals and schools or a conglomeration of houses.

Figure 23: Trickling filter (Nakuru, Kenya).

Figure 24: Constructed wetland system (Matany Hospital, Uganda).

Use / disposal: Use / disposal of the treated wastewater and faecal sludge is similar to System 3.

Considerations: The sustainability of system 4 depends highly on a well functioning and properly managed sewer and treatment facility. There must be a well-defined structure for operation and maintenance. The system also requires relatively high capital investment costs, so it is worth to invest in a proper planning. Especially because this system can be an upgrade of System 3, when considered already during the planning phase. There must be a constant supply of water to ensure that the sewers do not become blocked and energy supply.

5.3.5 Compatibility of the systems

The four systems described above are not an "either – or" decision but rather alternatives adaptable for different areas within Kyela town. They are suitable for parallel implementation as well as a stepwise approach.

Table 12 describes the compatibility of the different sanitation systems in regard to area, common infrastructure and a possible upgrade from one system to the other.

Area: The systems are generally suitable for different areas within Kyela Township, dependent on population density, water supply, etc. System 1 - Waterless sanitation system with ventilated improved pit latrine for example, is suited for unplanned and agricultural areas, ideally with a low groundwater level. Pour flush systems with a three chamber septic tank are additionally adequate for densely populated and planned areas.

Common infrastructure: Infrastructure can be commonly used by different systems. For instance, vacuum trucks may empty conservancy tanks as well as septic tanks. A centralised wastewater treatment plant may treat the wastewater from conservancy tanks and from the sewer network. For a properly working wastewater treatment, one must consider that already during planning.

Upgrade: Apart from system 2 – Waterless system with UDDTs, all others can be upgraded to system 4 - (Simplified) sewer with (decentralised) treatment plant.

Table 12: Compatibility of the systems.

	Area within Kyela Township	Common infrastructure	Upgrade
S1 – Waterless system with ventilated improved pit latrine	Unplanned and agricultural area.	Vacuum truck – emptying of conservancy tank. Sludge drying bed - treatment of sludge from pits. Trickling filter or oxidation ponds - treatment of wastewater from conservancy tank.	The conservancy tank can be used for an upgrade to system 4.
S2 – Waterless system with UDDTs and waterless urinals	All areas especially agricultural areas and schools.	Co-composting – treatment of faeces (and urine).	Parallel system
S3- Pour flush system with three chamber septic tank	All areas especially densely populated and planned areas.	Vacuum truck – emptying of septic tank. Sludge drying bed - treatment of sludge from septic tank. Trickling filter or oxidation ponds - treatment of wastewater from conservancy tank.	To system 4
S4 – (Simplified) sewer with (decentralised) treatment plant	Densely populated and planned areas	Conservancy tank and septic tank to reduce the diameter of the sewer. Trickling filter (or oxidation ponds) – treatment of wastewater.	

Table 13 summaries the environmental impact of the four different sanitation systems. The degree of environmental protection is highly dependent on a proper operation of the whole system. The groundwater can easily be protected by implementing a urine diverting dry toilet system, simply because the collection chambers are constructed above ground and secured from rainwater run-off. But this waterless system can also be an environmental hazard, if the toilet is not used properly (for example faeces and urine are getting mixed), rainwater enters into the collection chambers or the urine collection tank is overflowing, etc.

Table 13: Environmental impact of the different systems.

	Environmental protection
S1 – Waterless system with ventilated improved pit latrine	Pit system: Significant environmental pollution, especially of the groundwater. The impact is increasing with higher population density. Conservancy tank: Non problematic environmental impact, if the faecal sludge is adequately treated.
S2 – Waterless system with UDDTs and waterless urinals	Non problematic environmental impact, if the system is operated properly.
S3- Pour flush system with three chamber septic tank	Septic tank with overflow: Limited environmental impact, if the accumulated sludge in the tank is emptied regularly. Conservancy tank: Non problematic environmental impact, if the wastewater is properly treated.
S4 – (Simplified) sewer with (decentralised) treatment plant	Non problematic environmental impact, if the system is operated properly.

5.3.6 Storm water drainage

The importance of an extension of the current drainage system in Kyela Township is obvious. The current practise of draining storm water out of town can be complemented with rainwater retention and infiltration in urban areas. It is a sustainable alternative to traditional drainage systems. Infiltration supports groundwater recharge, can decrease groundwater salinity, allows smaller diameters for sewers (resulting in cost reduction) and improves water quality of receiving waters because pollutants and high peak flow are effectively controlled (Dierkes, et al., 2002).

Dierkes et al. (2002) describes a wide variety of different infiltration systems. In the following the ones which seem to be suitable for Kyela town are mentioned.

Infiltration without storage represents the easiest and cheapest possibility and contains of (i) infiltration of greened or vegetated soils (infiltration basins) and (ii) permeable pavements. The first option seems to be most appropriate for Kyela and is described in more detail.

The easiest way to infiltrate runoff is to direct the water onto a vegetated soil area, where it can infiltrate into the ground. This method has the advantage to be very cost effective and shows normally very high pollution retention capacities but can only be used under specific conditions. The soil must be highly permeable and the area must be large enough. The surfaces should be planted with different grasses according to the local climate. To maintain an infiltration area the grass must be cut regularly. Calculation formula is described by Dierkes et al. (2002)[8] and design criteria by Burkhard R. et al. (2001)[9].

Infiltration with on-ground storage is suitable if the hydraulic conductivity of the underground is not high enough. Storm water is retained in swales or basins before infiltration.

Infiltration swales are grassed waterways. The runoff is filtered by the soil and pollutants are removed effectively. Large amounts of water infiltrate towards groundwater levels but evaporation also takes place. Infiltration basins are designed to temporarily store surface runoff and to treat storm water by

[8] Link to download: http://www2.rgu.ac.uk/subj/search/Publications/viewpub.asp?ID=1394.
[9] Link to download: http://www.hydrocon.com.au/pdfs/Research-Publications/General/dierkes-2wsud-brisbane.pdf.

filtration. They are very similar to swales, but the connected area is larger. Both system follow special design criteria which are described by Dierkes et al., 2002.

Infiltration with subsoil storage has the advantage of not taking up valuable surface area and is protected from improper use.

Infiltration is provided by a permeable artificially-constructed gravel filter trench (percolation trenche), which is covered by shallow soil or by pavements. They require installation of special inlets to prevent coarse sediments and oil/grease from clogging the reservoir. Infiltration pipes are perforated pipes, which are covered by shallow topsoil or traffic used pavements.

Combinations of the infiltration devices can be used additionally to drainage channels. Planning should take into account the characteristics of different areas within Kyela Township, aiming to implement an appropriate system.

Further details and design criteria for rainwater management techniques are described by Burkhard R. et al. (2001) and Dierkes et al. (2002).

6 FROM PLANNING TO IMPLEMENTATION

During the last years, a range of planning approaches have been developed. The common goal is to enable urban communities and municipalities in low-income countries to plan and implement cost effective sustainable sanitation services. Two participatory planning approaches are the basis for further recommendations within the frame of this study, (i) The NETSSAF Participatory Planning Approach (NETSSAF, 2008)[10] and (ii) Community-Led Urban Environmental Sanitation Planning (Lüthi et al. 2011)[11]. Both publications contain a variety of different tools which are useful to guide through a planning process and are highly recommended by the consultant.

6.1 Preconditions

For a successful implementation of a planning process, an enabling environment is necessary to plan, implement and sustainably operate sanitation systems and services. The following checklist for a preliminary assessment of an enabling environment is adopted from Lüthi et al. (2011):

1. The level of **government support**, in terms of political support and favourable national policies and strategies. → Is there local authority support for participatory approaches in terms of political support and favourable national policies?
2. The **legal and regulatory framework**, with appropriate standards and codes at national and municipal levels. → Does the legal framework feature standards and codes at national and municipal levels that allow or promote alternative and/or low-cost sanitation options?
3. **Institutional arrangements** that accept and support participatory approach used. → Do the existing institutional arrangements support the multi-stakeholder & participatory approach?
4. **Effective skills and capacity** ensuring that all participants understand and accept the concepts and planning tools. → Do the key stakeholders to be involved possess basic skills and capacity that can be developed to a sufficient level during the planning process?
5. **Financial arrangements** that facilitate the mobilization of funds for implementation. → Are there sufficient financial arrangements to ensure implementation and proper O&M?
6. **Socio-cultural acceptance**, i.e. matching service provision to the users' perceptions, preferences, and commitments to both short- term and long-term participation. → Is the socio-cultural environment conducive to full community participation and does it not exclude certain groups?

[10] Link to download: http://www.netssaftutorial.com/
[11] Link to download: http://www.eawag.ch/forschung/sandec/publikationen/sesp/dl/clues_guid.pdf

6.2 Participatory planning

The 7 step approach described below provides a rough overview of a possible strategy to improve the sanitation situation within Kyela Township. Every step includes a short description, the expected output and a brief analysis of what each step means specifically for Kyela Township.

STEP 1 Launch of the planning process

This is the official launch of activities in the sanitation planning process. The purpose of this step is to bring together all key stakeholders to develop a common understanding of the environmental sanitation problems in the intervention area and agree on the process of how to address them.

Output: The stakeholders generate a protocol agreement, an agreement on the project boundaries and an agreement on the overall planning methodology and process.

Kyela Township: Various stakeholders are well aware of the sanitation problems within Kyela town, but there is no common understanding and agreement respectively on how to solve them. A workshop can bring all key stakeholders together to discuss possible strategies, to approve a planning methodology and to agree on responsibilities. This could follow a similar pattern as for the Mtwara Sustainable Sanitation Workshop facilitated by the GIZ in September 2010, but with more focus on the Kyela situation. Detailed information of this workshop is summaries in the proceedings of the workshop (GIZ, 2010).

STEP 2 Creation of demand

Step 2 aims to sensitise the community on environmental sanitation and hygiene issues and focuses on demand creation for sanitation services. The focus of this step is on awareness raising through dissemination and information campaigns that create lasting behaviour changes in the community.

Output: Increased awareness on sanitation related problems and increased demand for appropriate sanitation infrastructure and services among the local population. Demand for sanitation is created when end-users have motivation, opportunity and ability to invest in a sanitation system which suits their needs and aspirations.

Kyela Township: The Department for Public Health is already planning an awareness creation and education campaign on sanitation related issues via Kyela Radio Station and through schools. A successful demand creation campaign is a continuous process, which uses different methods like sanitation marketing (a combination of behaviour change and advertising affordable sanitation products and services), community or school health clubs (a forum for information and good practice), posters and flyers or drama groups informing about the value of good sanitation and hygiene behaviour. The GIZ may consider implementing these activities within the context of their partnership with WASH United, an international initiative that promotes water, sanitation and hygiene for all and uses the channel of sports to overcome barriers and taboos in sanitation and hygiene.

STEP 3 Detailed assessment of the current situation

Step 3 provides necessary background information for all future planning steps. The collected information will provide the technical details necessary for system design and identifying and prioritising community needs.

Output: A detailed status assessment report for the intervention area includes a stakeholder analysis, baseline data, and a thorough assessment of the enabling environment and current levels of service provision.

Kyela Township: Two recently prepared documents are a valuable basis for this step: this Rapid Need Assessment for Low-Cost Sanitation Concept for Kyela Town, and Detailed Study Report Kyela Town (seureca and NETWAS Tanzania Ltd, 2011). Both documents are lacking detailed information and do not take into account the community´s views and experiences.

STEP 4 Prioritisation of community problems and validation

In step 4, stakeholders deliberate the findings and implications of the assessment report, and identify and prioritise the leading general and environmental sanitation problems in the community. It also contains an assessment of the community's willingness to pay for improvements.

Output: A validated assessment report and an agreed-upon list of priority problems in the community.

Kyela Township: During discussions and interviews with different authority representatives, the consultant observed a high consensus of the main sanitation problems among the respective authorities. These problems are currently a list of issues without a prioritisation among the different stakeholders and leave out completely the opinion of the community.

STEP 5 Identification of service options

The overall objective of step 5 is to identify and reach a decision about the most suitable sanitation system(s), by considering technical (hardware) and non-technical (software) issues, based on the defined priority problems. The selection of options is based on a system approach, considering all components required for the adequate management of the different waste streams (human excreta, greywater, stormwater and solid waste), the users of the system, the collection at household level, transport, treatment, and management of end products.

Output: The main outcome is an agreement on sanitation systems to be studied in greater detail. The agreement reached by the community and the local authorities should be based on an understanding of the management, O&M and financial implications of the selected systems.

Kyela Township: A first pre-selection of possible systems is provided by this study, → Chapter 5 Low-cost sanitation concept for Kyela Town. But it shall be considered that these systems are only a first pre-selection, which is missing a comprehensive data analysis as well as any consideration of community needs. This list of pre-selected options is likely to be effective and sustainable in Kyela town, but they need a further assessment of their O&M and skill requirements, financial considerations (capital and recurrent costs), and institutional, technical as well as social characteristics.

STEP 6 Development of an action plan

Step 6 is setting to prepare an action plan for the implementation of the sanitation options selected in step 5. The focus of this step is the development of a plan where the sanitation planning can be integrated into the overall planning for the municipality. The action plan must be implementable by the community, the local authorities and the private sector as well as contain an operation, maintenance and management plan to ensure the sustainable functioning of the sanitation systems.

Output: A costed and funded action plan that follows time sensitive, output-based targets. The plan must include an overall sanitation strategy with technical, financial, institutional and human resources issues, a time-frame as well as elements related to operation and maintenance.

Kyela Township: For Kyela Township an Interim Land Use Plan 2008 – 2018 exists. This plan considers also water supply and sanitation issues, but only on a very general basis. As a rule, a sanitation action or master plan must be integrated into the already existing land use plan and further strengthen the cooperation between the different authorities currently responsible for sanitation issues.

STEP 7 Implementation of the action plan

Step 7 is the logical conclusion: to implement the sanitation action plan. The action plan is translated into work packages which ultimately become contracts for implementing the service improvements. This step includes also the implementation of the O&M management plan.

Output: Implemented sanitation systems and services.

Kyela Township: Sanitation improvements are currently implemented only in bits and pieces. Any activities are undertaken as a response to pressing problems and are not an active process along a commonly agreed strategy.

CROSS CUTTING TASKS

Awareness raising and communication - An effective awareness-raising campaign will employ a variety of different communication approaches and techniques to ensure that the central message is received and understood by a diverse audience.

Capacity development - Skills and capacity are an important component of an enabling environment. Therefore it may be necessary to build capacity by conducting trainings, sharing information and

raising awareness. In order to sustain a new system, it will also be valuable to anchor the required knowledge for its operation and maintenance into the community after implementation. On a longer perspective, sanitation services can be a new employment opportunity.

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7 ANNEX

7.1 List of contacts and meeting participants

7.1.1 Contact details

Table 14 contains the contact details of key informants in the context of this study:

Table 14: Contact details of key informants

NAME	DEPARTMENT	POSITION	CONTACT
Dr. Festo John	Public Health	District Medical Officer	+255.(0)784.646780
Heita-Mwampamba Nangula	GIZ Tanzania	GIZ Advisor to the Water Sector Reform Programme	+255.(0)784.589074
Hosiana Alexander	Primary Education	Representative of District Educational Officer	+255.(0)765.858020
Kasmgo Clemens	Kyela District Council	District Executive Director	kuswak@yahoo.com
Mbunga Erasto	Kyela Township Authority	Health Officer	
Mgata Martha	Secondary Education	Representative of District Educational Officer	+255.(0)755.974562
Mkungume Abu	Kyela Water Supply and Sanitation Authority (KYUWSA)	Managing Director	+255.(0)784.773127
Mkuyu Joram	Kasumulu Water Supply and Sanitation Authority	Managing Director	+255.(0)755.798613
Mutta Behenobi	Town Planning	District Town Planner	+255.(0)754.768775
Mwakalasi Oswald	Kyela Township Authority	Township Executive Officer	+255.(0)754.311224 osilasi@yahoo.com
Mwakibuka Ndiyo	Kyela Township Authority	Economist	+255.(0)765.963626
Mr. Marco Njau	District Agricultural and Livestock Department	District Agricultural and Livestock Development Officer	+255.(0)784.923514
Schimanowski Daniel	Regional Administrative Secretariat (RAS) Mbeya	GIZ Advisor to RAS	+255.(0)25.2504033

7.1.2 Participants of first formal meeting

Date: 4.11.2011

Venue: Office of the District Executive Director

Participants:

- Dr. Festo John
- Hosiana Alexander
- Kasmgo Clemens
- Mgata Martha
- Mkungume Abu
- Mkuyu Joram
- Mutta Behenobi
- Mwakalasi Oswald
- Mwakibuka Ndiyo
- Schimanowski Daniel

7.1.3 Participants of second formal meeting

Date: 10.11.2011

Venue: Meeting room of Kyela District Council

Participants:

- Dr. Festo John
- Mbunga Erasto
- Mkungume Abu
- Mutta Behenobi
- Mwakalasi Oswald

7.2 Satellite images of Kyela town

Figure 25: Satellite image of the population distribution in Kyela town by 2008.

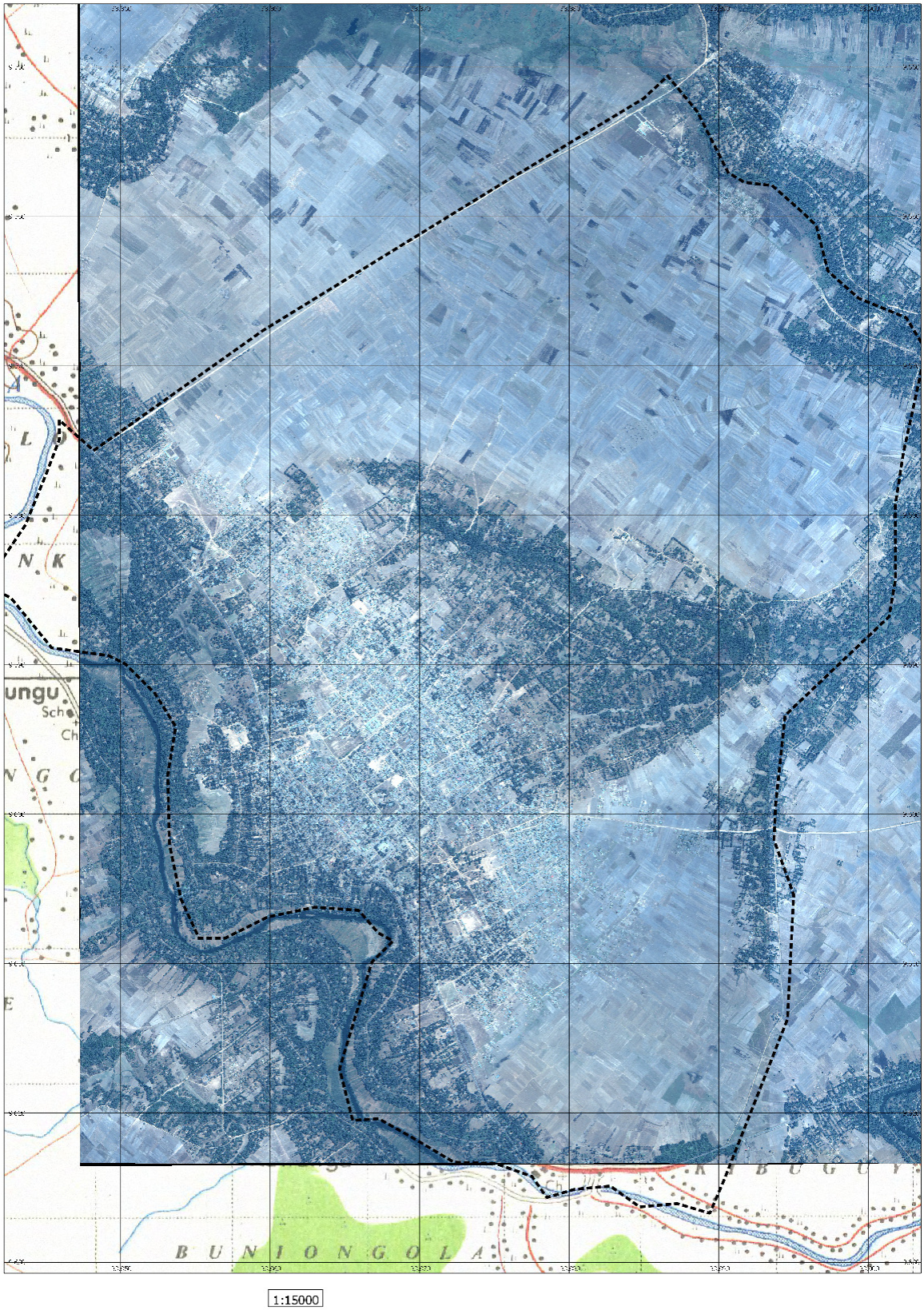

Figure 26: Satellite image of Kyela town by 2011.

7.3 Land use plans for Kyela Township

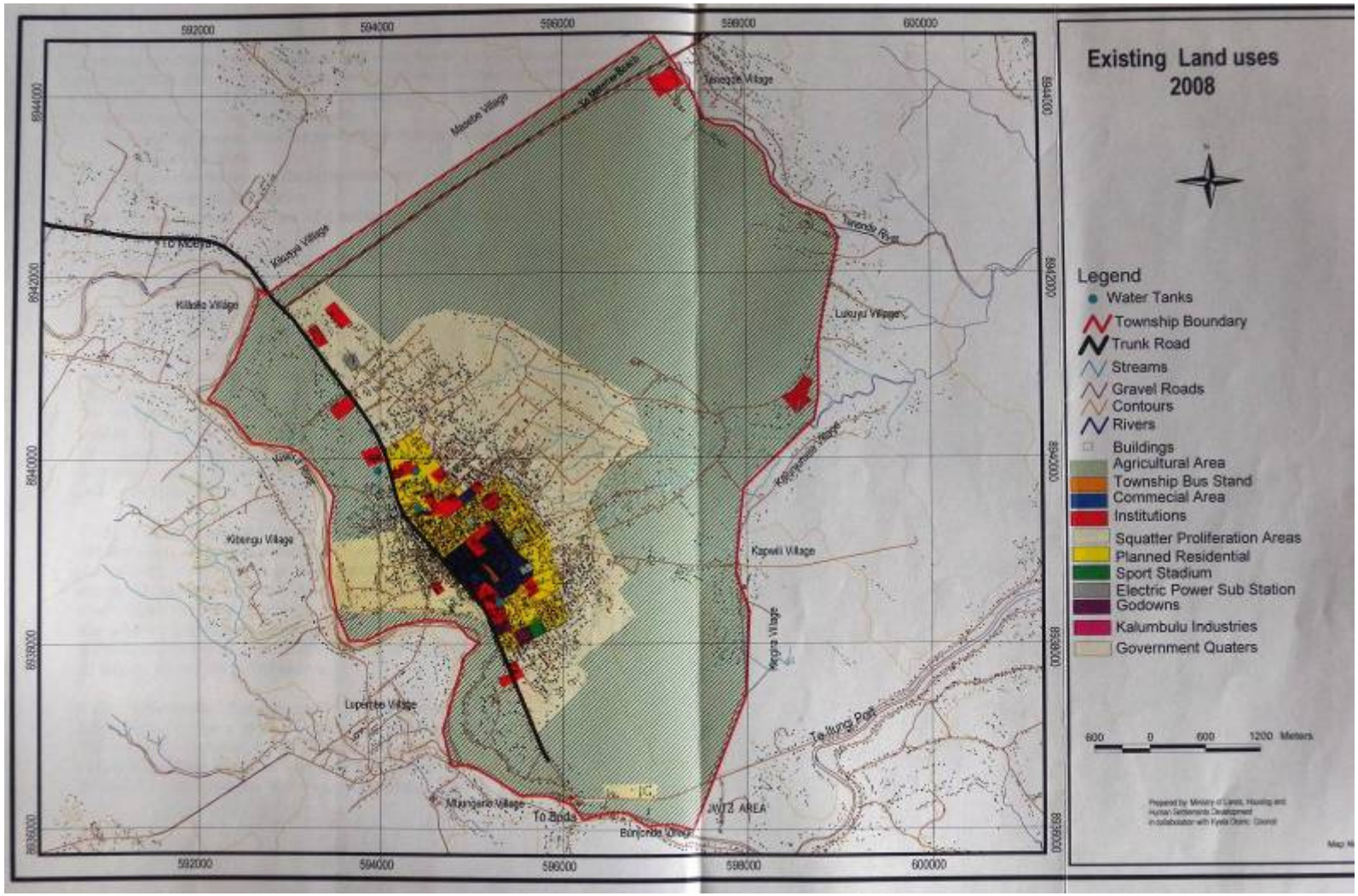

Figure 27: Existing land uses by 2008 (Ministry of Lands, Housing and Human Settlements Development, 2008).

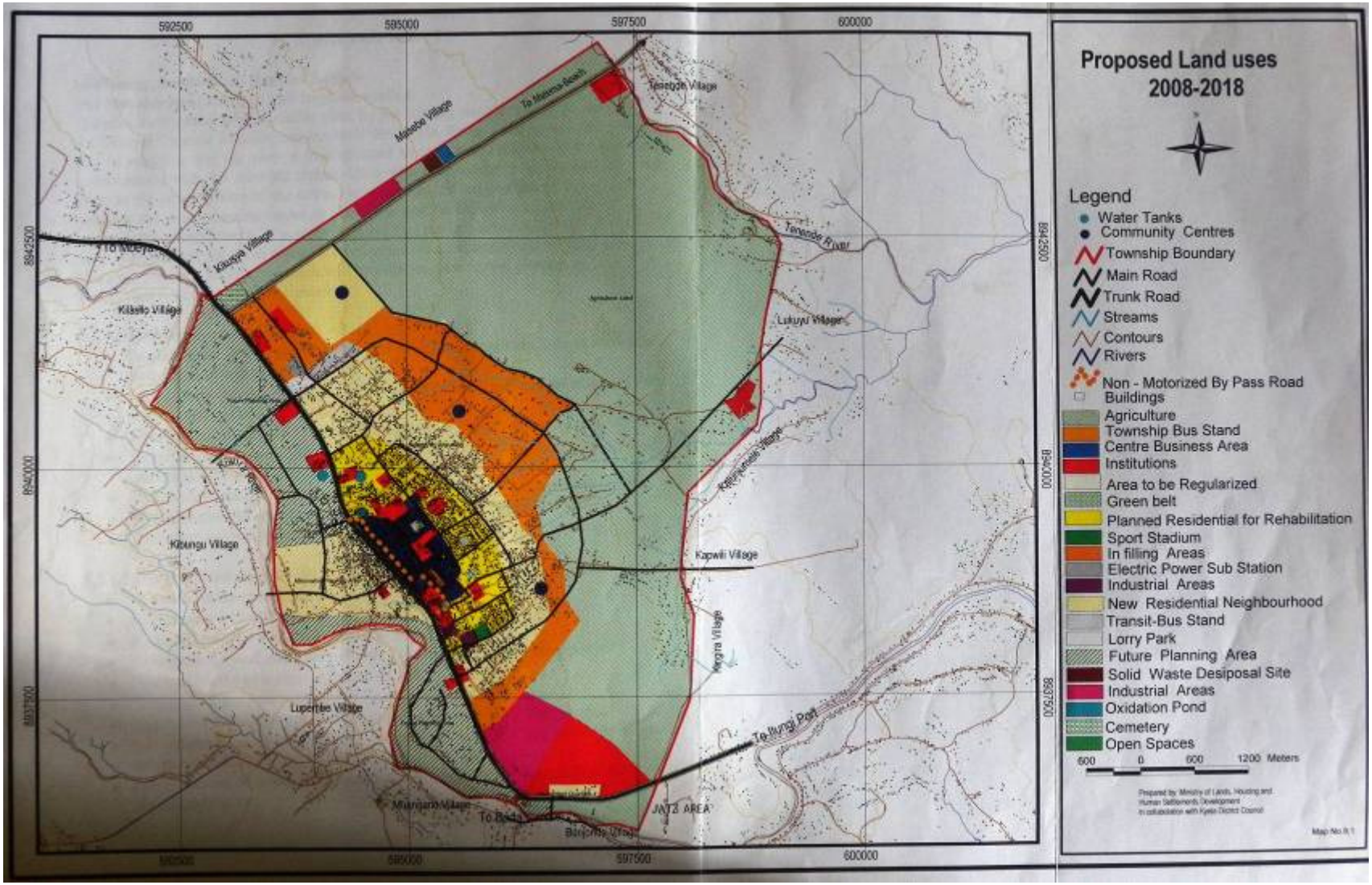

Figure 28: Proposed land uses 2008 – 2018 (Ministry of Lands, Housing and Human Settlements Development, 2008).

7.4 Main water supply distribution network

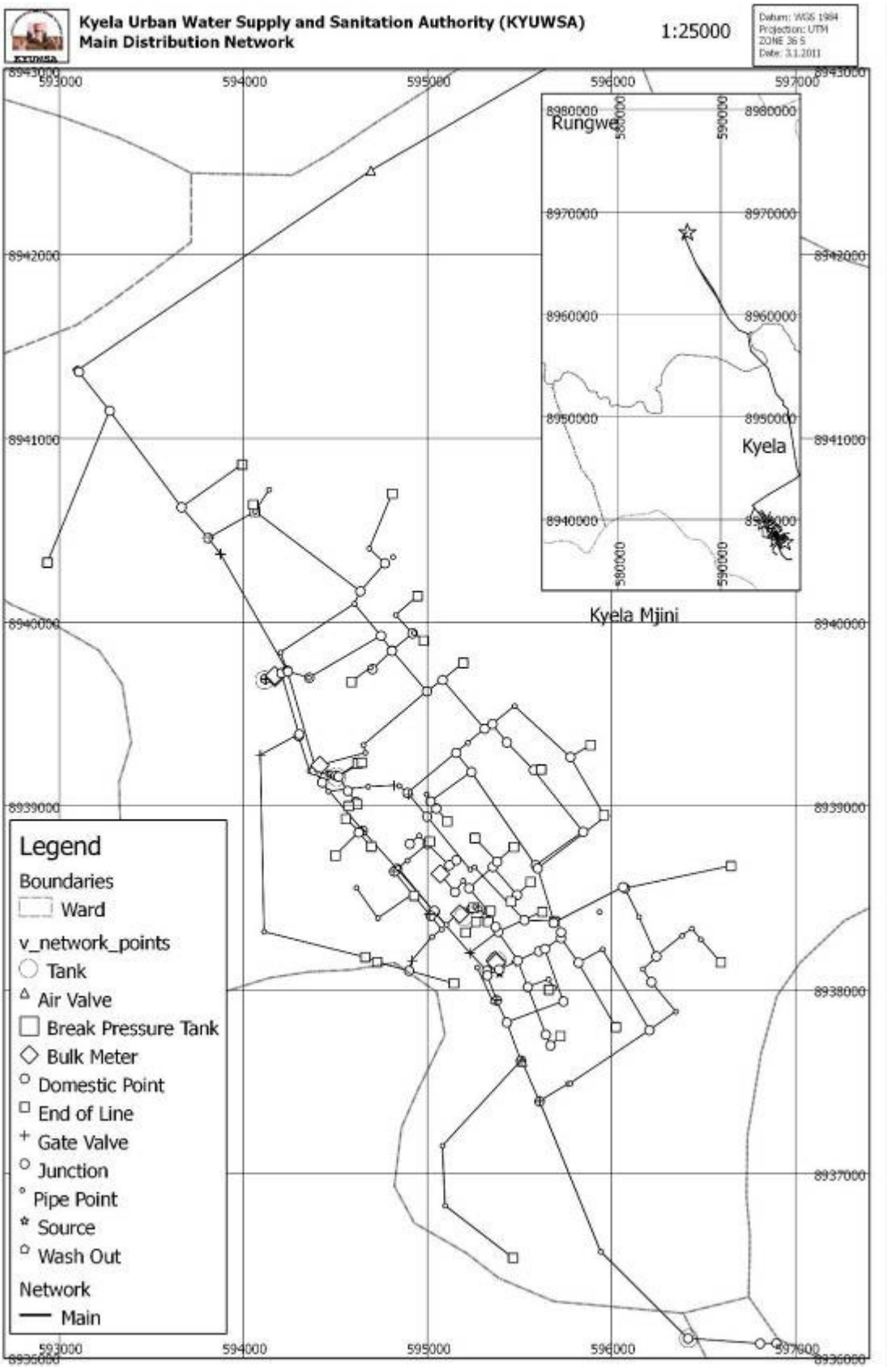

Figure 29: Water supply distribution network in Kyela town (2011).