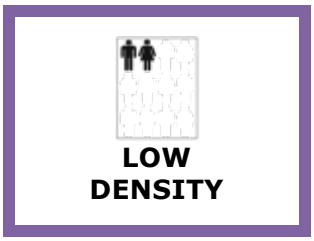
You have selected an area with the following characteristics:



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CHECK ADDITIONAL LOCAL DATA (E.g. High groundwater, prone to flood or outbreaks of disease)

Areas with high water table, and/or areas prone to flood or regular outbreaks of waterborne diseases (e.g. Cholera) pose serious risk to public health. These areas are considered "stress areas" requiring emergency intervention.

The combination of these **three parameters** + **additional local data** is useful for shortlisting suitable "environmental sanitation" solutions for specific areas in Dar es Salaam).

NOTE: SEEK EXPERT CONSULTATION BEFORE IMPLEMENTATION

Prior to implementation, it is essential to consult with environmental sanitation experts and key stakeholders, to identify the true landscape and needs of the beneficiaries. This can be conducted in the form of a feasibility study or field surveys in selected areas.

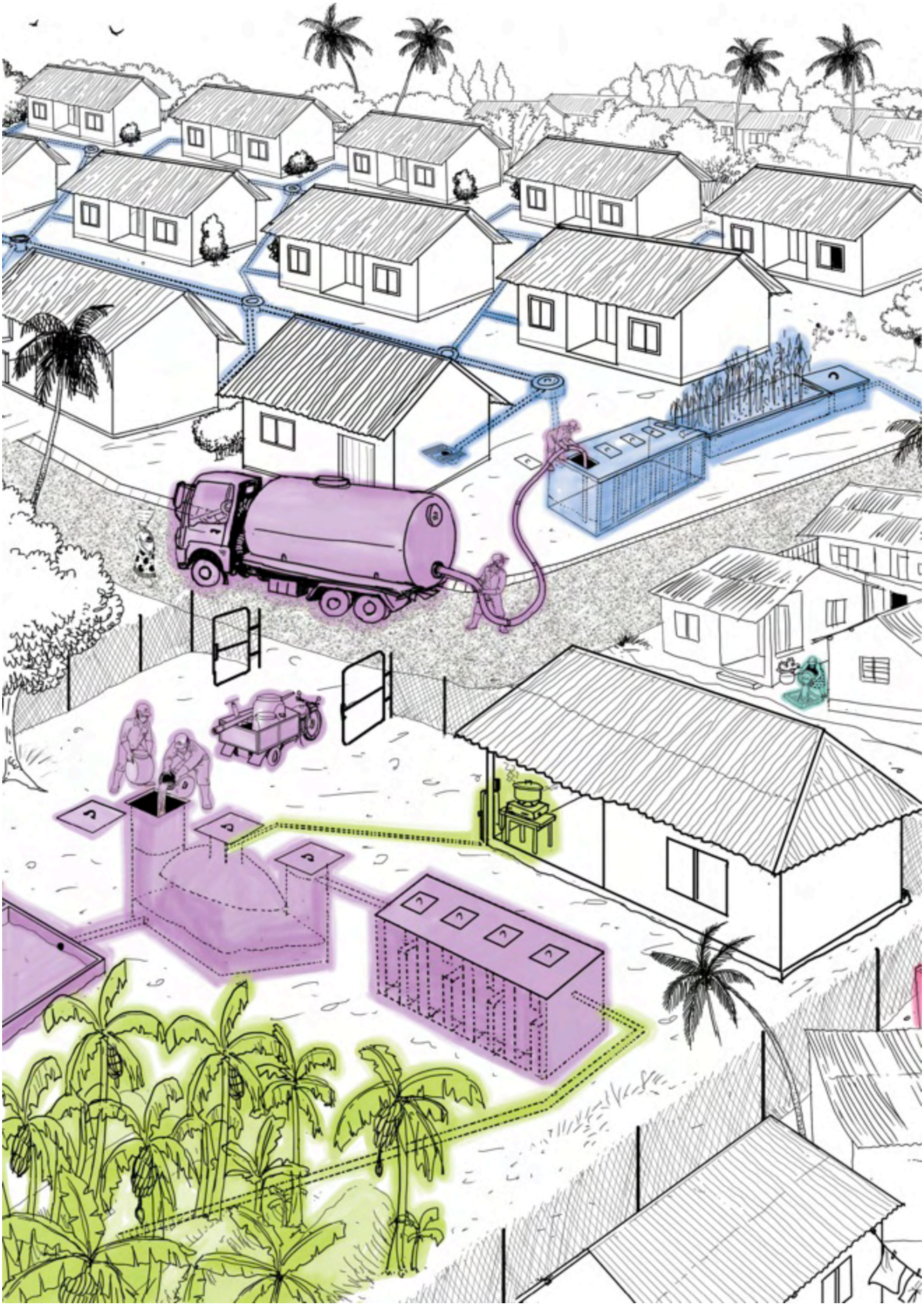
Selection of the most suitable sanitation solutions also needs to include a thorough economic analysis. **Only then can the most feasible environmental sanitation interventions for specific areas be implemented.**

Environmental sanitation is a holistic approach to achieving a sanitary urban environment, considering all aspects related to hygiene, notably those aspects directly linked to human health and quality of life. On the following pages, environmental sanitation options will be included under the categories of:

NOTE: FOR USE AS A GUIDE ONLY

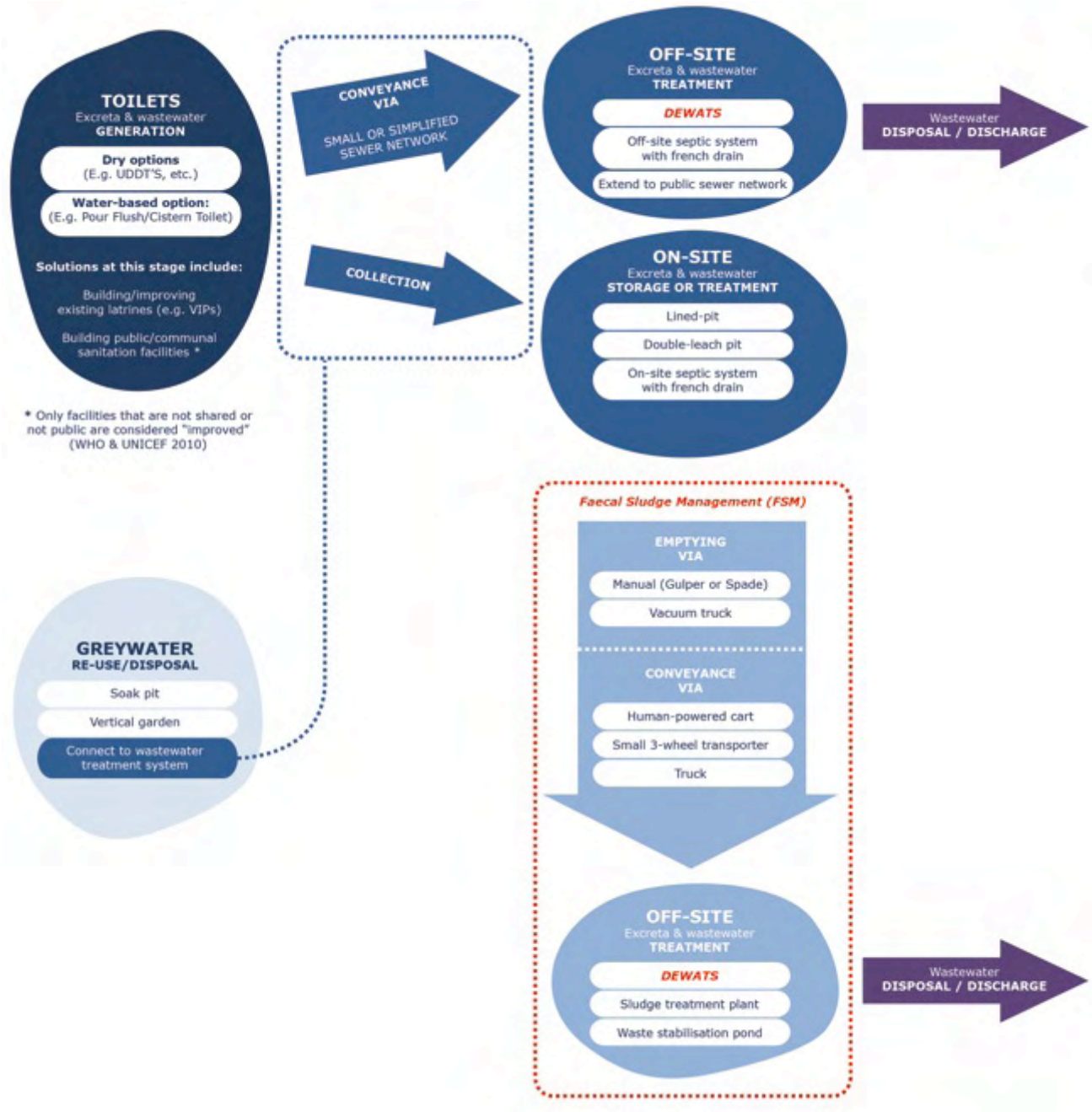
The recommendations within this document are intended as a guide only, as the first steps for planning city sanitation interventions or "which sanitation solutions go where?"

These recommendations assist the identification of feasible environmental sanitation service options for various areas of the city, as well as highlighting areas requiring urgent attention. However, it is important to note that the recommendations within the guide have been determined using data averages and estimations across a large area (macro-level) – therefore, these recommendations are not detailed prescriptions for immediate, micro-level intervention on the ground.



Sanitation, excreta & wastewater management (including greywater and faecal sludge)

The activities related to sanitation, excreta & wastewater management (including greywater and faecal sludge) can be understood as a part of a holistic "sanitation value chain", which considers all stages between the source of wastewater generation until the final disposal or discharge point. For example:



Recommended solutions for this selected area:

Toilet type (Source of wastewater generation)

Improved individual latrines (e.g. VIPs): might include the construction of a new substructure (e.g. pit lined with cement blocks, sand cement rings or normal blocks), new superstructure (e.g. shelter made from cement blocks with roofing sheets, and walls lined with tiles, paint or plaster) and/or a new user interface (e.g. improved slab, or pour-flush pan). These latrines can be further improved with the addition of a ventilation pipe (Ventilated Improved Pit) or through connections to on-site septic solutions or sewer networks.

Cost estimate for one household:

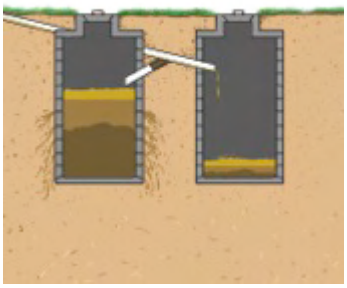
For new improved latrine (1.5m x 1.5m):
- Superstructure made with cement blocks and corrugated steel roofing = TSh 546,000
- Improved ceramic pour-flush toilet basin, complete with fittings and PVC pipe connections = TSh 31,500

Note: An un-lined or un-reinforced pit cannot support a heavy superstructure (see lined-pit information below).

For raised VIP latrine:
- Superstructure = TSh 500,000
- Substructure (2m deep lined pit) = TSh 475,000
- Integrated latrine slab = TSh 77,000

Annual operation, maintenance and cleaning costs to maintain a hygienic latrine (e.g. buckets, water, hose, gloves, disinfectant, etc.) = TSh 165,000

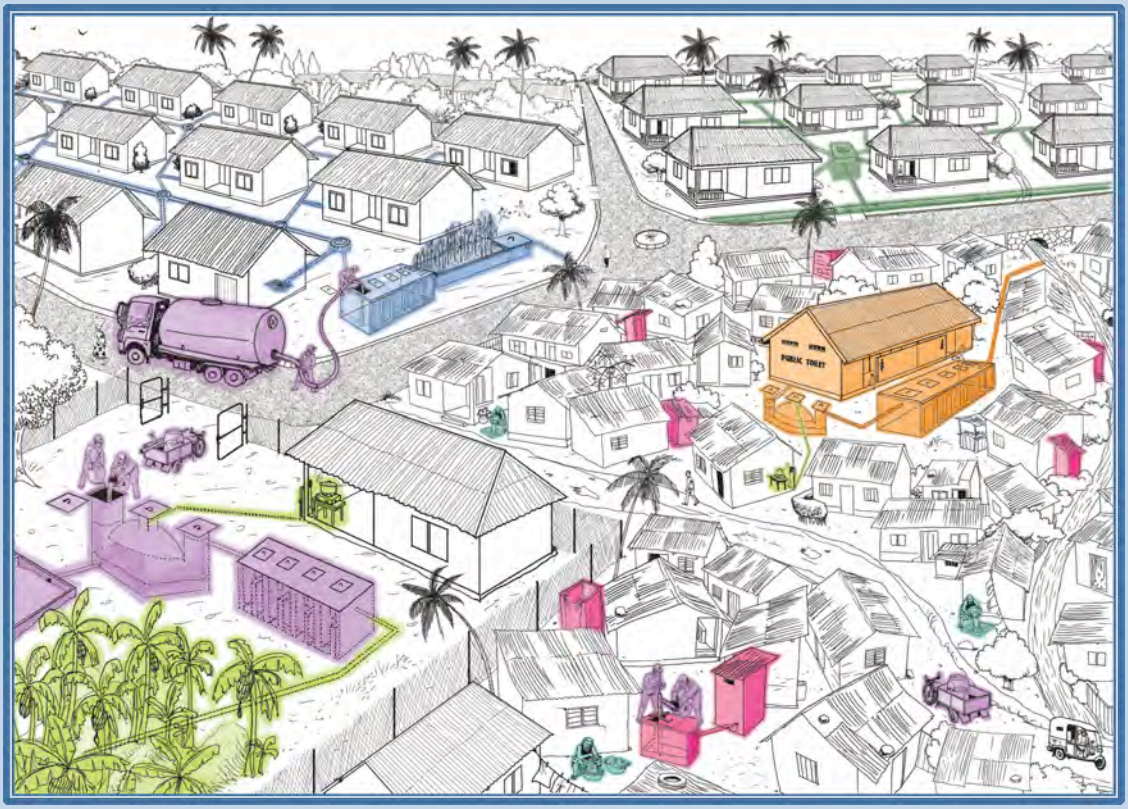
On-site storage/treatment



Double leach-pit: Two alternating partially lined (sealed on the bottom) pits, where one pit is used until it becomes full. At the same time, wastewater slowly permeates into the surrounding soil, which allows the easy removal of degraded, dewatered soil.

Cost estimate for pour-flush latrine (off-set double pits):
- Substructure = TSh 550,000
- Superstructure = TSh 502,000

Innovative solutions beyond conventional systems: *Introducing DEWATS & FSM*



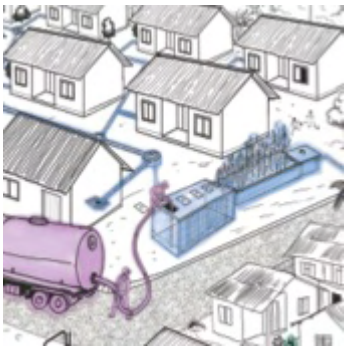
DEWATS **Decentralised wastewater treatment solutions:** are designed to manage and treat domestic wastewater, septage and pit latrine sludge as well as organic industrial wastewater. As illustrated in the image above, DEWATS offer decentralised and flexible alternatives to centralised sewerage systems, with many possible applications. DEWATS represent the intersection between wastewater generation and treatment before it is discharged into the environment. They can be designed as stand-alone, on-site systems, or connected to an off-site public sewer system.

DEWATS use low-technology components (E.g. Anaerobic baffle reactors, biogas digesters, planted gravel filters) that can be built with locally available materials. As such, they provide an affordable alternative to – or integrated into – centralised sewerage systems, and can be operated and maintained through public or private service providers. DEWATS provide wastewater treatment and disposal solutions for:

- Single households (one source of wastewater) & housing schemes (multiple sources of wastewater)
- Public/communal sanitation centres or ablution facilities
- Greywater disposal
- Faecal sludge management

FSM **Faecal sludge management:** provides professional, on-demand services for the emptying of pit latrines, followed by the safe treatment and disposal of faecal sludge (combined with transfer station or full treatment system). According to the level of accessibility, services are performed either manually (Gulper with pushcart or small 3-wheel transporter) or with vacuum truck.

Conveyance to off-site treatment



Small or simplified sewer network connected to off-site septic solution: Small sewerage networks are constructed using smaller diameter pipes laid at a shallower depth and a flatter gradient than conventional sewers. Typically these pipes lead to a decentralised wastewater treatment solution (DEWATS).

Cost estimate:
Per linear meter of sewer network:

- 70mm PVC pipe = TSh 17.820
- 110mm PVC pipe = TSh 20,800
- 160mm PVC pipe = TSh 33,150

*This estimate excludes additional costs associated with manhole covers or inspection chambers, which may be +20% depending on the terrain and over site-specific factors. Costs will also vary according to the depth of excavation required. This estimate is for a shallow depth of up to 500mm.

Faecal sludge emptying, conveyance and treatment

Manual emptying: The process of manually removing sludge from on-site sanitation solutions using human-power. Emptying can be done using buckets and shovels, or by using a portable, manually operated pump specially designed for sludge (e.g. "Gulper"). Sludge is then transported to a sludge treatment plant in containers using a pushcart or small 3-wheel transporter. Each trip can transport 350 litres.

Cost estimate:
- Per trip = TSh 30,000 – 40,000 per trip (depending on the distance to wastewater treatment plant; household income level; and level of difficulty in emptying)

Small vacuum tanker system: Small storage tank with a vacuum pump powered by an engine, mounted to a trailer and transported by small, motorised vehicle. This system is for emptying and transporting faecal sludge, septage and urine to a sludge treatment plant. Humans are required to operate the pump and manoeuvre the hose, but sludge is not manually lifted or transported. Motorised emptying and transport, is fast and generally efficient. This option is considered an upgraded version of manual faecal sludge emptying.

Note: Thick or dried material cannot be pumped and garbage in pits may block the hose, and must be manually removed prior to emptying. Initial capital costs are higher and spare parts may be not available locally, but due to the efficiency and increased collection of sludge, it can still be financially viable. Each trip can transport 800 litres.

Cost estimate:
- Per trip = TSh 40,000 – 60,000

Sludge treatment plant: After faecal sludge is emptied and conveyed from on-site sanitation solutions, it is treated using settling and drying processes. First the sludge is placed into a settling tank or biogas reactor, where suspended solids sink to the bottom and lighter constituents (wastewater) float to the surface. Solids are then released into a basin to dry under sun exposure, and prepared for use as soil conditioner. Lighter constituents are treated through an Anaerobic Baffle Reactor (ABR) followed by a gravel filter, and discharged accordingly.

Cost estimate:

- DEWATS for receiving 0.5m3/day wastewater (for 20 people)
  - Construction = TSh 10,800,000

- DEWATS for receiving 4m3/day wastewater (5500 households)
  - Construction =TSh 35,000,000
  - Operation & maintenance = TSh 120,000/month (fuel for vehicles)
  - Salary for operators = TSh 150,000/month per person

Greywater re-use/disposal

Connect to individual disposal facility (e.g. Vertical garden/agriculture): Greywater can be used to water small-scale, vertical gardens at household level or diverted for irrigation in urban agriculture.

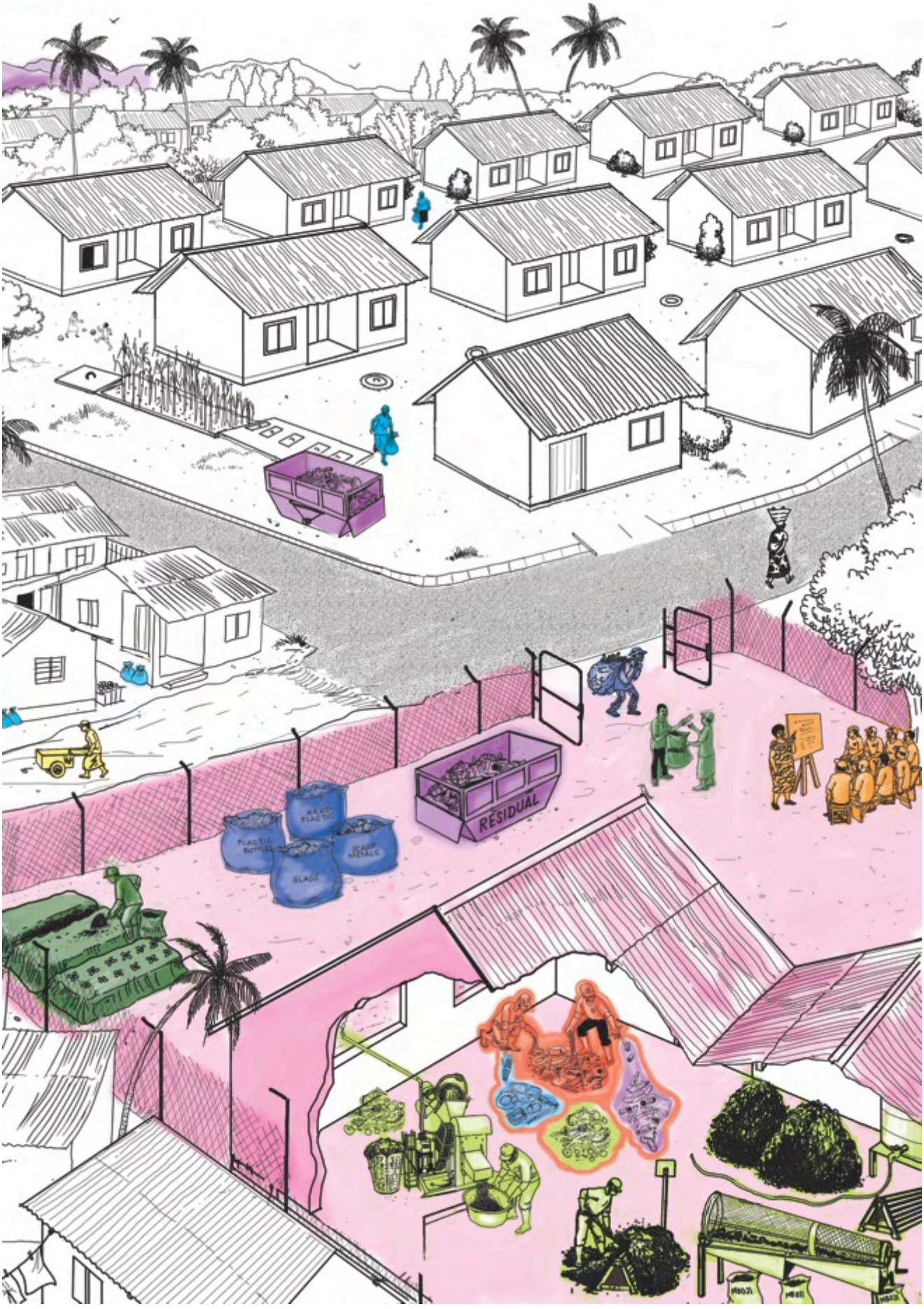
Cost estimate:
Vertical garden (using rice-bag) = TSh 30,000 filled with layers of gravel, soil and sand. On the sides of the bag, holes are cut and seeds are planted.

Vertical garden (constructed) = TSh 130,000 (1.5m high, 40cm diameter) filled with layers of gravel, soil and sand. On the sides of the bag, holes are cut and seeds are planted.

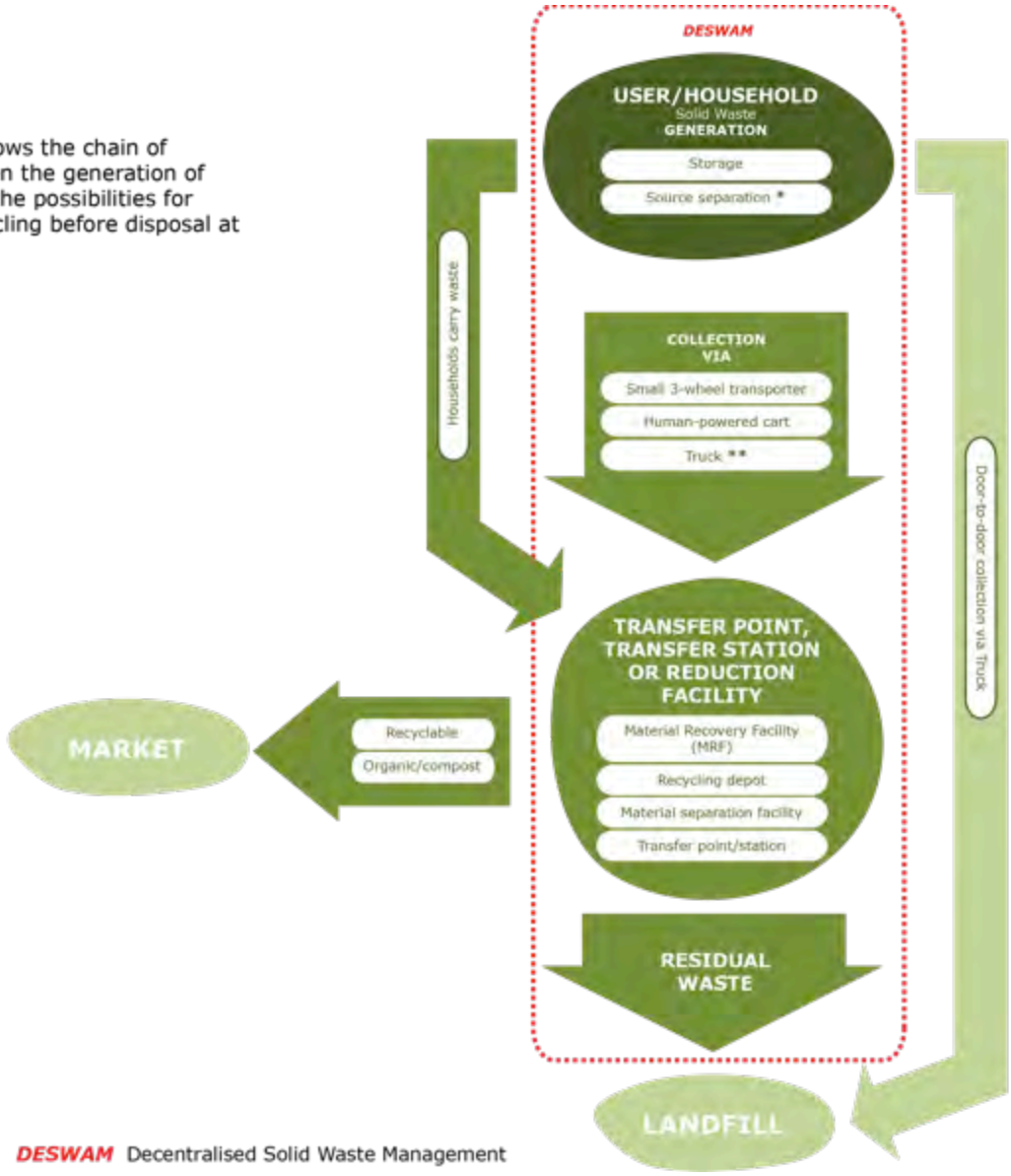
Connect to existing wastewater system:

See Page 5

See Page 15 for more information on how to integrate these options into existing centralised drainage and stormwater infrastructure, following adequate treatment.


RESIDUAL
MIXED PLASTIC
PLASTIC BOTTLES
SCRAP METALS
GLASS

This flowchart shows the chain of processes between the generation of solid waste, and the possibilities for reduction or recycling before disposal at landfill.



DESWAM Decentralised Solid Waste Management

Source separation

Source-separation is recommended for all areas, however some specific pre- and post-conditions are required:

- Pre-conditions - collection methods must be modified:
  - Trucks with separate compartments
  - Recycler collects waste directly from households
- Post-conditions - there must be somewhere for the separated waste sources to go, such as a market or further processing industry:
  - Compost
  - Plastic / paper / metal recycling

NOTE: Collection via Truck is optional, although, it is not advisable to separate waste with reduction methods. Due to the large volume of waste collected via truck, separation is too costly and labour intensive.

Household storage: refers to the storage of solid waste in either a plastic bag, dustbin or other form of container that can be sealed/closed to prevent insects or rodents from entering, and reduce the risk of causing disease.

Cost estimate:
- Small plastic dustbin (shown) = TSh 13,000
- Medium plastic dustbin = TSh 22,000
- Large plastic trash bin (shown) = TSh 80,000 – 100,000

Household source separation: refers to the process of manually separating solid waste into fixed categories, according to collection and re-use demands. Ideally, solid waste is separated into categories such as: organic, recyclable, paper and residual waste, and can be stored in bags, buckets or dustbins prior to collection.

Cost estimate:
See above

Recommended solutions for this selected area:

Solid Waste collection methods

Households carry waste

To transfer point / station: In areas unable to receive door-to-door household collection services via truck, individuals can carry contained solid waste to either transfer stations or fixed transfer points where waste can be deposited and temporarily stored.

Cost estimate:
N/A

Door-to-door household collection

Pushcart or 3-wheel transporter: refers to human-powered or simple, motorised methods for collecting solid waste from each household.

Cost estimate:
See below

Truck: refers to motorised solid waste collection services, where waste is collected from households or transfer points/stations and transported to a final landfill site.

Cost estimate for truck collection and disposal at landfill site (Pugu):

- Per trip = 150,000 – 200,000 (depending on the distance to landfill site and the geography of the sub-wards).

NOTE: This option is only feasible in this area if managed by service provider

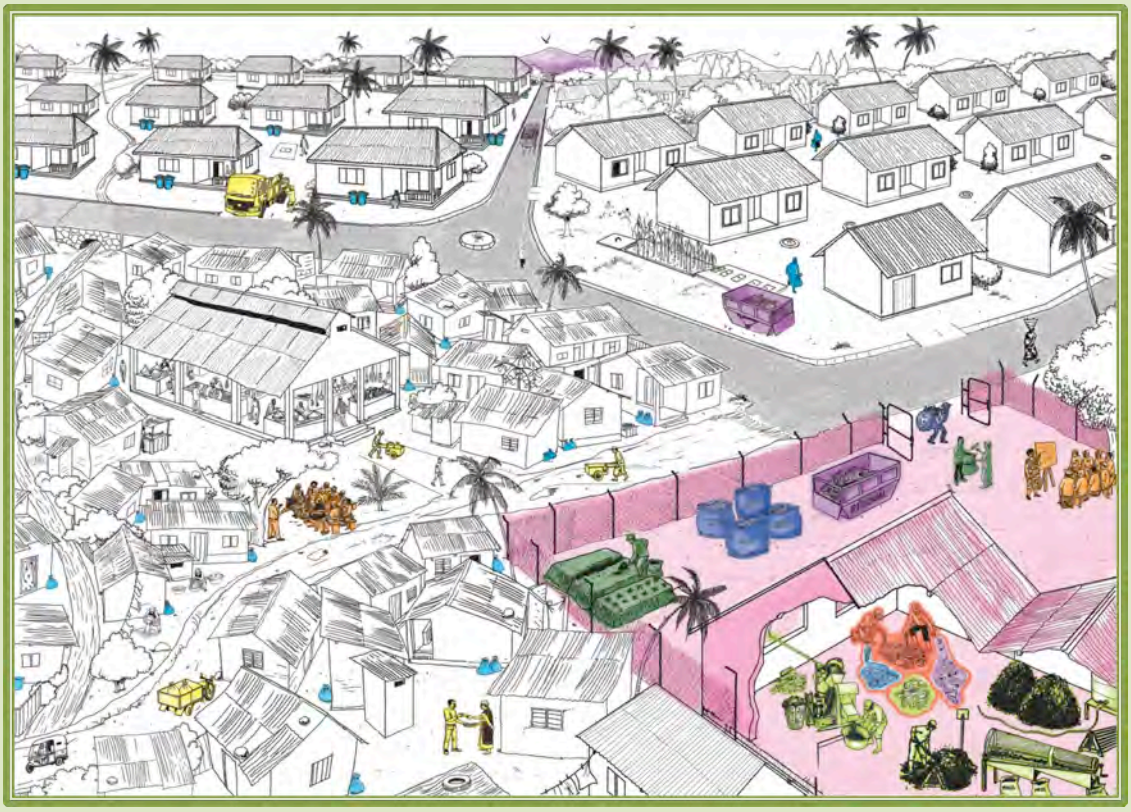
Solid waste Collection fees

Cost estimates for formal monthly contract with municipal waste collection services (according to municipal guidelines):

- Low income = TSh 3,000 – 5,000 / household / month
- Middle income = TSh 10,000 / household / month
- High income = 15,000 / household / month

Formal monthly fees should be paid in all areas, however under some circumstances service providers do a "pay-as-you-go" system, where each bag of waste deposited incurs a fee of TSh 500 – 3,000 (depending on the weight)

Innovative SWM solutions beyond conventional systems: *Introducing DESWAM for waste recovery*



Decentralised Solid Waste Management (DESWAM) is based on the integration of decentralised waste management systems with urban planning and public waste management systems. DESWAM systems are characterised by their simplicity, which is expressed by on- or off-site basic waste separation into three groups – organic waste, recyclable waste, and residual waste – and by implementing simple composting technologies on available sites. Through waste separation and reduction processes, DESWAM can help reduce the amount of solid waste transported to final landfills by up to 60%, while also allowing for alternative income generation for solid waste management operators.

A DESWAM facility can be designed to manage varying amounts of incoming solid waste per day, depending on individual community needs. The applications of this system are primarily based on three management principles: waste separation, recycling and reuse through composting. For every DESWAM facility, these principles are combined according to their specific characteristics to a customised treatment system.

Waste recovery options (DESWAM)

Material Separation Facility (MSF): is a facility where waste is separated into recyclable and residual waste, but NO composting is done on the site. Organic waste is only separated at this facility if a Compost Facility is available on another site and waste can be transported there for processing. All recyclable waste is collected and sold for profit to individuals or recycling industries and all residual waste is stored in temporary waste holding containers until being transported to landfill.

Cost estimate: Not Possible

- Prices for such facilities vary significantly based on scale and incoming types of waste. Contact BORDA directly for more information.

Transfer point: is an open-air, temporary waste storage and collection points, where waste accumulates. When a sufficient amount of waste has accumulated at the transfer point, this waste can be removed and transported to a waste reduction facility or to the final landfill site.

Transfer points may consist of skip containers, tractor-trailers, or other forms of temporary containment for solid waste. Alternatively it might just be an open piece of land.

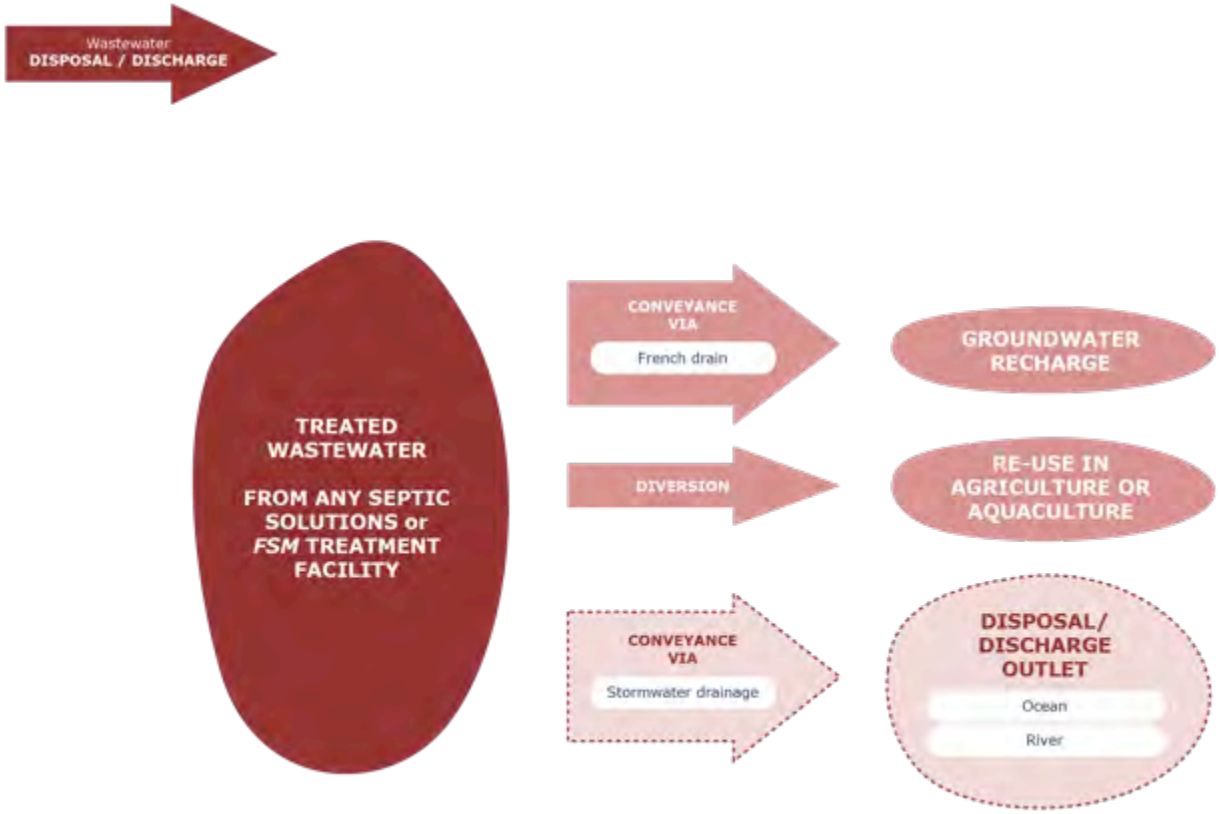
Cost estimate:
8m3 skip container = TSh 8,000,000 – 10,000,000

Transfer station: is a larger, formal waste transfer facility where waste is brought in, often processed somehow (e.g. sorted and/or compressed). When a sufficient amount of waste has accumulated at the transfer station, this waste can be removed and transported to a waste reduction facility or to the final landfill site.

Cost estimate: Not Possible
Prices for such facilities vary significantly based on scale and incoming types of waste, as well as the cost of the land. Contact BORDA directly for more information.

Stormwater drainage & discharge of treated wastewater

The aforementioned solutions for wastewater treatment are designed to be integrated into existing centralised drainage and stormwater infrastructure (where possible), **following adequate treatment**. Post-treatment disposal options includes the following:



*** In areas where stormwater drainage does not connect to discharge outlets located at rivers or the ocean, drainage needs to be extended. To ensure this is done correctly, it is advised the construction of stormwater drainage should occur first at these discharge outlets, and work backwards up-stream towards the source of generated wastewater.**

Additional factors and planning requirements to be considered:

- Regulated discharge permits
- Regulated number of sources discharging into one area

Recommended solutions for this selected area:

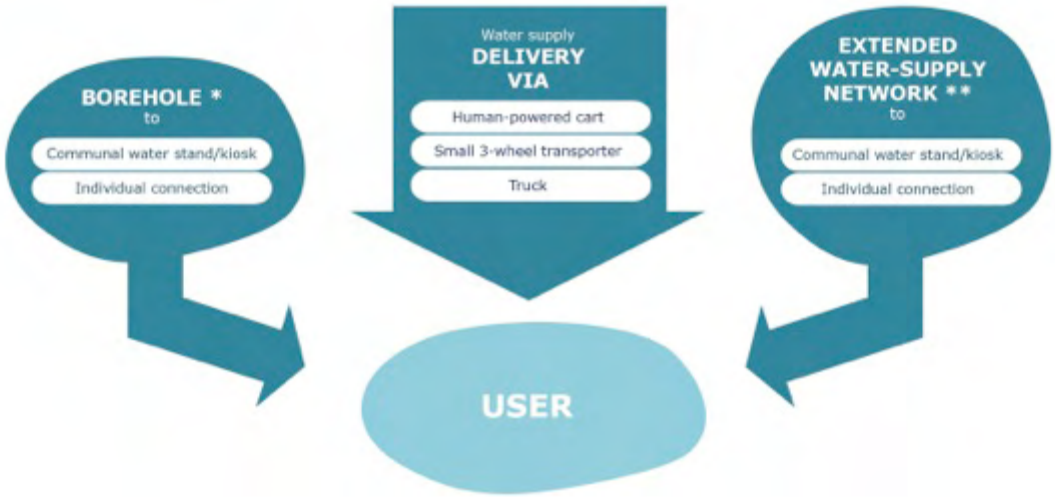
Disposal / discharge

Disposal / discharge outlet: is the point where stormwater and treated wastewater is released back into the surface water bodies, e.g. ocean or rivers.

Cost estimate:

- Costs vary significantly based on the volume of wastewater generated, as well as the length of drainage connecting the source of treated wastewater to the point of discharge.

Water supply



*** Borehole connections should not be located within a 50m radius of unlined pit latrines, as per Tanzanian Law.**

**** If the centralised water supply network is extended, the wastewater network and treatment facilities must also be extended in the same areas, so that consumption and discharge quantities are matched**

Recommended solutions for this selected area:

Borehole

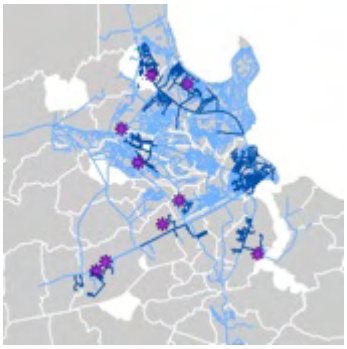
Borehole: is a narrow shaft bored into the ground, either vertically or horizontally, in order to access underground water reserves. Individual boreholes may be accessed by one household or shared by a number of households.

Communal water stands/kiosks: refers to a shared connection to the public water supply network, where water is accessed through a public water stand or kiosk.

Cost estimate:

- Construction of communal facility = from TSh 2,000,000-4,000,000. Costs vary significantly depending on structure and design of water stand/kiosk and drainage system.

Extend to water supply network



Centralised water supply network refers to a vast network of underground pipes, which connect water sources (e.g. ground of surface water) directly to the end users.

Individual connection: refers to a household connection to the public water supply network.

Cost estimate:
- Connection to DAWASA network = TSh 380,000-420,000
- Per m3 water = TSh 1,098

Communal water stands/kiosks: refers to a shared connection to the public water supply network, where water is accessed through a public water stand or kiosk.

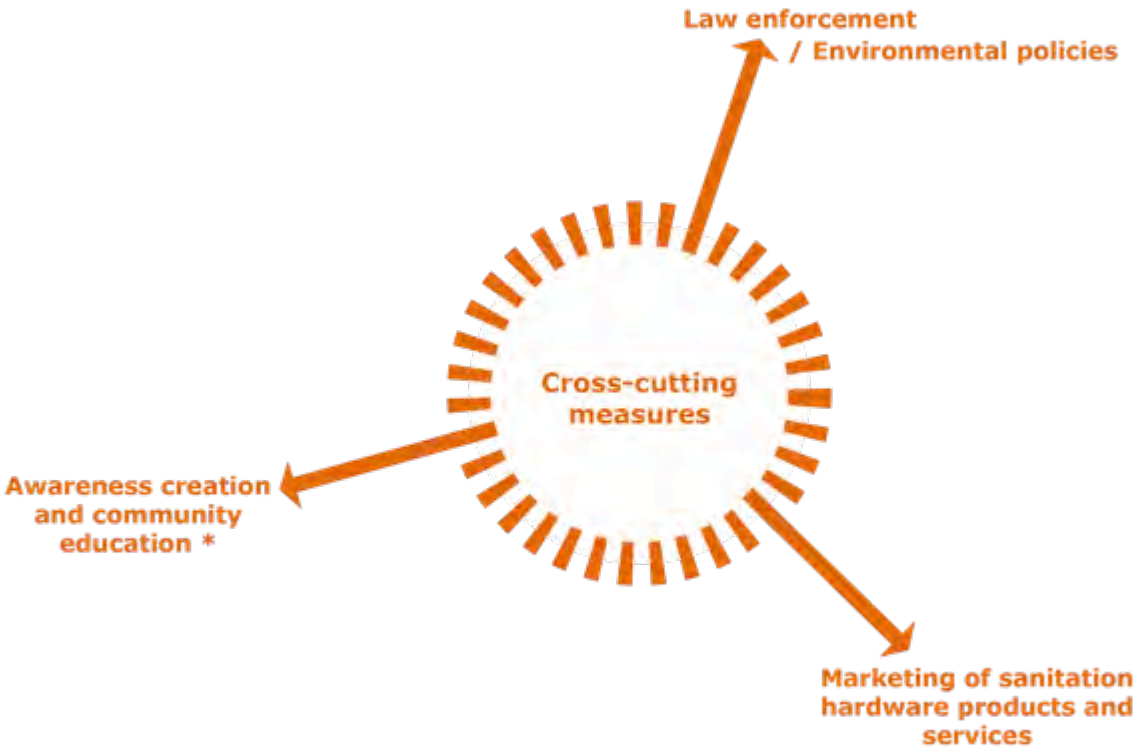
Cost estimate:
- Construction of communal facility = from TSh 2,000,000-4,000,000. Costs vary significantly depending on structure and design of water stand/kiosk and drainage system.

Cross-cutting measures




Certain cross-cutting measures need to occur wherever a sanitation intervention takes place!

The following cross-cutting measures include "software" activities to complement and reinforce the abovementioned "hardware" or service options:



Recommended measures for this selected area:

Awareness creation and community education, can come in many forms, such as:

- Mobile environmental sanitation exhibition
- Community training workshops
- House-to-house education
- Public environment "clean-up" events, e.g. *Nipe Fagio* beach clean-up events
- Community competitions, e.g. "Cleanest Mtaa Programme" in the Mlalakua subwards

Cost estimate:
No cost estimate here, as budget will determine how much can be done.

On-site sanitation marketing: might come in the form of a mobile Sanitation Exhibition, which moves around to various communities to exhibit information on sanitation options and technologies.

Cost estimate:

- One day Sanitation Exhibition (includes 3-4 staff & volunteers) = TSh 3,400,000 (+ TSh 300,000 for faecal sludge expert to attend one day):
    - 1 day on site
    - 1 day set-up
    - 1 day take-down/re-stock

Additional resources & references

For more detailed information on the options within this catalogue, please refer to the following resources:

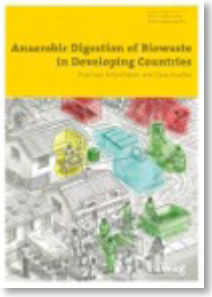
BORDA, 2009
"Decentralised Wastewater Treatment Systems (DEWATS) and Sanitation in Developing Countries: A Practical Guide"

WEDC, 2004
"Catalogue of Low-cost Toilet Options: for Dar es Salaam"

Eawag / Sandec, 2014
"Compendium of Sanitation Systems and Technologies"
2nd Edition

Eawag / Sandec, 2014
"Faecal Sludge Management book"

UN-HABITAT, 2008
"Constructed Wetlands Manual"



Eawag / Sandec, 2014
"Anaerobic Digestion of Biowaste in Developing Countries: Practical Information and Case Studies"

People's Development Forum (PDF) & Polytechnic University of Madrid, 2013
"Bidhaa za usafi wa mazingira kwa bei nafuu: CHOO BORA na MAZINGIRA SAFI. Wlaya ya Chamwino"

References

- Bill & Melinda Gates Foundation (BMGF) (2012) *Water, sanitation & Hygiene - Strategy Overview*, Global Development Programme.
- Gutterer, B., Sasse, L., Panzerbieter, T. and Reckerzügel, T. (2009) *Decentralised Wastewater Treatment Systems (DEWATS) and Sanitation in Developing Countries: A Practical Guide*. Loughborough University, UK: Water, Engineering and Development Centre (WEDC).
- Obika, A. (2004) *Low-cost toilet options - a catalogue: Social marketing for urban sanitation.* London, UK: WEDC.
- Tilley, E., Lüthi, C., Morel, A., Zurbrügg, C. and Schertenleib, R. (2008) *Water and Sanitation in Developing Countries: Compendium of Sanitation Systems and Technologies*. Swiss Federal Institute of Aquatic Science and Technology (EAWAG): Dübendorf, Switzerland.
- WSSCC (2000) *Bellagio Statement: Clean, Healthy and Productive Living: A New Approach to Environmental Sanitation* [online], WSSCC Working Group Environmental Sanitation, Swiss Federal Institute of Aquatic Science and Technology (EAWAG): Dübendorf, Switzerland.