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DETAILED PROJECT BRIEF FOR THE PROPOSED CONSTRUCTION OF SIMPLIFIED SEWERAGE SYSTEM TO BE CONSTRUCTED AT SINZA D, SINZA WARD, UBUNGO MUNICIPALITY IN DAR ES SALAAM REGION

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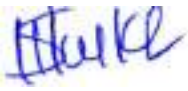
Mr. Melkizedeck Stephano	Environmentalist	Registration on Progress	

Executive Summary

Project Overview

The proposed Sinza D Simplified Sewerage System Project is a key intervention under the Off-Grid Sanitation Project being implemented by DAWASA (Dar es Salaam Water and Sanitation Authority) under the oversight of the Ministry of Water (MoW), with financial support from the World Bank. The project aims to improve access to safe and affordable sanitation services in the high-density Sinza D area in Dar es Salaam by constructing a simplified sewerage network and decentralized treatment system.

Need for the Project

The project responds to the acute sanitation challenges in urban informal settlements where conventional sewerage systems are not feasible. Currently, most households in Sinza D rely on poorly maintained on-site sanitation facilities, leading to public health concerns and environmental degradation. The intervention will support SDG 6 (Clean Water and Sanitation) by improving wastewater management, enhancing environmental quality, and promoting public health.

Project Components

- Pipeline network (total length: approximately 6 km) – Smaller diameter sewer pipes (100mm) that collect wastewater from households and communal facilities.
- Manholes and inspection chambers - Maintenance and monitoring points for operations, preventing blockages.
- Household connections (estimated 300 households) - Linking household waste discharge points (toilets, greywater drains) to the main line. Where households currently use pit latrines or septic tanks, conversion works will be done to allow safe flow into the sewer.
- Wastewater treatment Plant - Sustainability and standard compliance of final effluent before discharge.

Project Location

The project is located in Sinza D, Ubungo Municipality, Dar es Salaam. It is characterized by high population density, poor sanitation coverage, and proximity to residential structures and natural water bodies. Maps showing the project area, nearby households, and the adjacent river/stream have been prepared and are included in the main report.

Site Selection and Alternatives

The site was selected based on:

- High population density with low sanitation coverage and high disease incidence.
- Site Locations with respect to business land use, & buildings
- Soil type if allows shallow sewers
- Topography of the areas to allow gravity flow
- Access roads and paths to allow gravity routes of pipeline flows
- Availability of discharge/disposal of the wastewater
- Locally available of construction material

Alternative options including offsite sewer networks and conventional systems were assessed but deemed cost-prohibitive or technically unviable in the dense urban fabric of Sinza D.

Legal and Institutional Framework

The ESMP is guided by:

- National Environmental Policy (1997)
- Water Supply and Sanitation Act (2019)
- MoW's National Guidelines for Wastewater Management (2019)
- TBS Wastewater Discharge Standards (TZS 860:2006)
- World Bank Environmental and Social Framework (ESF)

Environmental and Social Risks

Risks identified include:

- Storm-water infiltration
- Odor emission and air quality degradation
- Water contamination from leaks or overflow
- Community displacement and land-use conflicts
- Health and safety risks during desludging
- Social unrest due to poor stakeholder engagement

A detailed Risk Register is included in the ESMP to manage these risks proactively.

Mitigation Measures

The project design incorporates several engineering and management strategies to mitigate risks:

- Sealed manholes and venting for odor control
- Proper drainage to manage stormwater
- Use of licensed sludge disposal sites
- Stakeholder engagement and GRM mechanisms

- Site fencing, signage, and access safety measures

Environmental and Social Management Plan (ESMP)
An ESMP table outlines:

- Environmental and social impacts
- Mitigation measures
- Responsible parties

- Estimated costs in Tanzanian Shillings 50,000,000/=

Impacts and mitigations are categorized by phase (Construction, Operation, and Decommissioning) and type (Environmental or Social).

Monitoring Plan
The monitoring framework includes:

- Key parameters (PM10, H_2S, noise, salinity, TDS)
- Frequency of monitoring (daily, monthly, quarterly)
- Assigned responsibilities (DAWASA, Contractors, MoW)
- Thresholds for compliance and reporting obligations

Stakeholder Engagement
Stakeholders engaged include:

- ✓ Local government authorities
- ✓ Community leaders and residents
- ✓ Women and vulnerable groups
- ✓ DAWASA field staff and operators

Key concerns raised included odor, land use, compensation, health impacts, and equitable access. Feedback was used to shape the design and mitigation plan.

Roles and Responsibilities

- ✓ Ministry of Water (MoW): Policy oversight, technical support, regulatory enforcement
- ✓ DAWASA: Project implementation, O&M, community engagement, reporting
- ✓ Contractors: Compliance with ESMP, safe construction practices
- ✓ NEMC & Local Authorities: Monitoring, enforcement, and grievance resolution

Conclusion
The Sinza D Simplified Sewerage System is a vital infrastructure project that addresses critical public health and environmental needs in urban Dar es Salaam. By following the ESMP, the project will manage environmental and social risks while promoting inclusive, sustainable sanitation development. The collaboration between DAWASA, the Ministry of Water, the World Bank, and local stakeholders will ensure responsible implementation and long-term benefits for the community.

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CHAPTER ONE

1.1 Background and Justification for the Intervention

Dar es Salaam is the former capital of the United Republic of Tanzania and largest city with the highest population. Based on statistic information on the sanitation condition of Dar es Salaam, most of residents depends on on-site sanitation including pit latrines, septic tanks, and some open defecation. As identified by previous studies, existing off-grid system is not fully functioning and some intervention with additional financial investment can support to re-establish the chain of the sanitation in those areas without proper sanitation service

In response to the persistent environmental and public health challenges arising from inadequate sanitation in urban and peri-urban areas, the Government of Tanzania, through the Ministry of Water and in collaboration with the Dar es Salaam Water and Sewerage Authority (DAWASA), is implementing the Off-grid Sanitation Project. This initiative is financed by the World Bank and aims to provide improved sanitation infrastructure to underserved communities that are not connected to the central sewerage network.

Sinza D, located in Ubungo Municipality, Dar es Salaam, has been identified as one of the high-priority areas for intervention due to its high population density, prevalence of on-site sanitation systems (many of which are poorly maintained or unsafe), and proximity to environmentally sensitive receptors such as surface water bodies and household clusters. These factors pose significant environmental and health risks, especially during the rainy season when wastewater and faecal sludge often overflow or seep into nearby open drains and streams.

The off-grid sanitation intervention proposed includes the shift away from unimproved toilet to improved ones, safe emptying and transportation of the waste to a treatment facility, and treatment and safe disposal of the waste into the environment. For sustainable sanitation service, a technology option suited for each area will also be applied. These technological interventions will include improved sanitation facilities at households, safe containment of faeces at household level, emptying the containment facilities in a safe and hygienic way, safe transportation, environmentally adequate treatment and disposal. The results expected from the Project is Design and construction of the Simplified Sewer System (SSS) at Sinza “D” Area.

The System will be connected to the new wastewater treatment plant, Anaerobic Baffle Reactor (ABR) that is also part of this designed

The ESMP is prepared in line with World Bank Environmental and Social Framework (ESF) requirements, Tanzanian Environmental Management Act (2004), and other relevant legal instruments. The document outlines mitigation, monitoring, and institutional arrangements for managing potential impacts.

1.2 Project Objective

The primary objective of the project is to provide a cost-effective and environmentally sustainable wastewater collection system to residents of Sinza D, where on-site sanitation systems such as pit latrines and septic tanks are common but often inadequate. The project seeks to enhance sanitation services through a simplified, community-friendly sewerage network that connects households and institutions to a decentralized wastewater management system.

1.3 Nature of the project

The proposed project concerns construction of Simplified sewerage system for public use at Sinza D Mtaa, Sinza Ward, Ubungo Municipality. The nature of the project enhances environmental protection through proper handling and disposal of domestic sewage. According to First Schedule of the EIA and Audit Regulations (Amended) of 2018, the nature of the project is small and entails no significant impacts. The project can be categorised as Type B2, which according to the regulations are “small-scale activities and enterprises that require registration but shall not require Environmental Impact Assessment. Further, the projects shall not require screening and scoping, rather, the Project Brief shall be examined and issued with an Environmental Impact Assessment Certificate”.

1.4 Scope of the ESMP

This Environmental and Social Impact Assessment (ESIA) outlines the potential environmental and social impacts associated with the design, construction, and operation of the proposed Simplified Sewerage System in Sinza D, and presents appropriate mitigation and monitoring measures.

The key works covered under this ESIA include:

- Surveying and trenching for sewer lines
- Installation of simplified sewer networks, including primary and secondary pipes
- Construction of inspection chambers and manholes
- Connection of selected households to the sewer line
- Construction of decentralized wastewater treatment facilities
- Restoration of community infrastructure affected by the works
- Community engagement, awareness campaigns, and capacity building for operation and maintenance.

1.5 Expected Environmental Improvements

The project is expected to result in substantial positive environmental and public health outcomes, including:

- Reduction in indiscriminate discharge of greywater and blackwater to open drains and water bodies.
- Protection of water quality in the nearby streams and rivers by reducing pollutant loads.
- Reduction in odour nuisances and fly/breeding insect problems in the area
- Improved overall sanitation conditions and environmental quality for the residents
- Improved public health due to better sanitation and reduction in disease vectors.
- Enhanced aesthetics and environmental hygiene within the community.
- Improved resilience to flooding due to reduction in blockage of drains by sewage waste.

CHAPTER TWO

2.1 PROJECT DESCRIOTION AND DESIGN

2.1.1 Project Location and Justification for Site Selection

The proposed simplified sewerage system will be implemented in Sinza D, a sub-ward in the Ubungo Municipality of Dar es Salaam Region. Sinza D is a densely populated urban settlement that lies approximately 10 kilometers west of Dar es Salaam city center and is part of the rapidly urbanizing Ubungo District. The area falls within the administrative boundaries of the Ubungo Municipality, which is known for its mixed land use, informal settlements, and pressing urban infrastructure challenges, especially in sanitation. The site falls in -6.791585°, 39.223071° geographical coordinates. These coordinates are expressed in decimal degrees and are referenced to the World Geodetic System 1984 (WGS 84) datum, which corresponds to EPSG:4326.

The WGS 84 coordinate reference system (CRS) is the globally recognized geodetic datum used for GPS positioning, satellite imagery, and international mapping standards. Its use ensures compatibility with national and international Geographic Information Systems (GIS), regulatory spatial databases, and infrastructure planning tools.

This area was chosen based on several criteria, including:

- High population density with low sanitation coverage and high disease incidence.
- Site Locations with respect to business land use, & buildings
- Soil type if allows shallow sewers
- Topography of the areas to allow gravity flow
- Access roads and paths to allow gravity routes of pipeline flows
- Availability of discharge/disposal of the wastewater
- Locally available of construction material

Other areas within Ubungo Municipality were considered, but Sinza D was selected as the pilot site due to its readiness, critical need, and manageable size for a simplified system prototype.

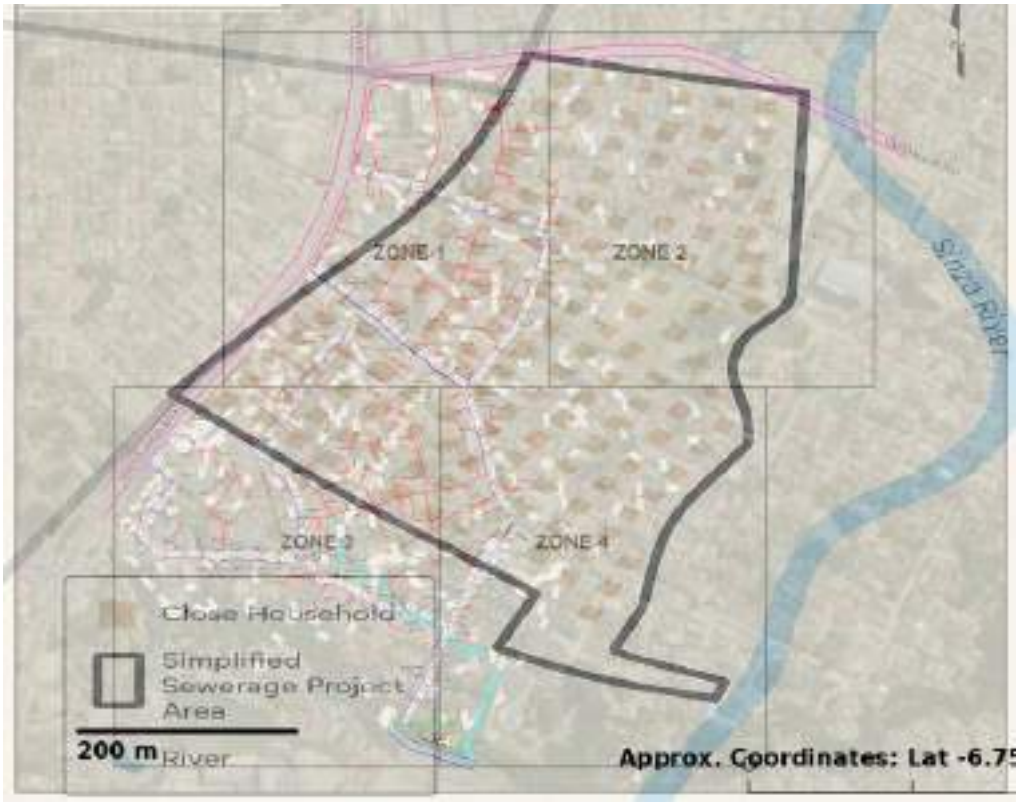


Figure 1-1 Overlaid topographical map for the proposed project

2.2 Accessibility

The proposed Simplified Sewerage System Project is located within Sinza D area in Ubungo Municipality, Dar es Salaam City. The project area is accessible through a well-established urban road network linking Sinza D with major arterial roads including Morogoro Road and Sam Nujoma Road, which serve as the main entry points for construction vehicles, materials, and equipment.

The primary access roads leading to the project area include paved (asphalt) and semi-paved municipal roads. Major access roads have an average carriageway width ranging between 7.0 meters, allowing two-way vehicular movement including light trucks and medium construction vehicles.

Internal access roads within Sinza D are predominantly local distributor and residential roads, with typical widths ranging between 4.0 to 6.0 meters. These roads are surfaced with asphalt in some sections, while some sections remain gravel or compacted earth. Pavement conditions vary from fair to poor, with visible surface distress in some locations including potholes, edge failure, and inadequate drainage.

Traffic Volumes and Movement Patterns

- Traffic volumes within the project area are generally moderate to high during peak hours, especially between 06:30–09:30 hours in the morning and 16:30–

19:30 hours in the evening. Peak traffic is primarily associated with commuter movement to and from the city center, nearby commercial areas, schools, and public transport routes.

- During off-peak hours, traffic volumes reduce significantly, allowing relatively smoother movement of service and delivery vehicles. The dominant traffic composition includes private cars, motorcycles (bodaboda), public transport minibuses (daladala), pedestrians, and occasional delivery trucks.

Potential Traffic Bottlenecks

- Several potential traffic bottlenecks have been identified that may affect construction logistics and community access:
- Narrow residential roads (4.0–6.0 m wide) may restrict simultaneous movement of construction vehicles and local traffic.
- High pedestrian activity zones, particularly, markets, places of worship, may experience congestion during trench excavation and pipe laying works.
- On-street parking and informal roadside trading reduce effective road width and may cause localized traffic obstruction.

Implications for Construction Logistics and Community Access

- Construction activities, especially trench excavation and pipe installation, may temporarily reduce available road width, affecting vehicular and pedestrian movement. Movement of construction trucks may also increase traffic congestion if not properly managed, particularly during peak hours.
- To minimize disruption, construction activities will be carefully scheduled, with material delivery planned during off-peak periods. Temporary traffic diversions, warning signage, and pedestrian access routes will be provided in consultation with Ubungo Municipal Council and traffic authorities

2.3 Land Ownership

The land allocated for the wastewater treatment plant and/or any centralized collection infrastructure has been officially allocated to DAWASA by the Ubungo Municipal Council. A formal allocation letter has been issued, confirming that the area with 1,757sqm is public land under the jurisdiction of the Municipal Council, and is exempt from encumbrances or private claims. This provision ensures smooth project implementation immediately related to land tenure conflicts. On the other hand, Sewer lines mainly pass through road reserves and public rights-of-way.

2.4 Project Activities

2.4.1 Mobilization or pre-construction phase

This phase entails mobilization of labour force, and equipment as well as acquisition of various permits as required by the law.

Other activities during this phase include;

- Topographical Survey for setting out purposes,
- Identification of utility infrastructures
- Construction Materials' source Investigation,
- Material transportation, storage and material preparation,

2.4.2 Construction phase

This phase entails all the necessary installations, site grading and placement of the facility components. The major activities include;

- Trench excavation and laying of 4" and 6" PVC pipes for collection of wastewater from households, depths ranging between 0.6 m and 1.5 m, depending on ground conditions, required pipe gradients, and connection levels at household sanitation facilities. Trench widths will generally range between 0.4 m and 0.6 m, adequate to allow safe pipe installation, jointing, and compaction works.
- Backfilling and paving of excavated trenches
- Construction of inspection chambers/junction boxes
- Construction of receiving chambers
- Connection of customers' latrines to the constructed network

2.4.3 Demobilization phase

This phase will involve the dismantling of temporary structures such as scar fording and removing/spreading spoil materials for proper restoration of the site.

Other activities include;

- General cleanliness of the area, that is clearance of all sorts of solid wastes (plastics, wood, metal, papers, etc);
- Deposit all wastes to the authorized dumpsite;

2.4.4 Operation phase

The phase entails the actual usage of the Simplified sewerage system where as the individual household will be discharging night soil directly to the system. The main task will be occasional clearance of the blockages and timely replacement of leaking pipes undertaken by DAWASA with the sole cooperation from household owners at the vicinity. Although simplified sewerage systems are designed to maintain self-cleansing velocities, periodic cleaning is necessary to remove sediment accumulation and prevent system blockage.

2.4.5 Decommissioning Phase

Decommissioning is not anticipated in the near future, as the completed facility will be serving a number of houses, which at present incur many costs to dispose fecal sludge and if not so tend to discharge illegally. However, if this will happen, may entail change of use (functional changes) or demolition triggered by change of land use.

2.5 Simplified Sewerage Design Consideration

The Sinza D Simplified Sewerage System (SSS) project has been designed as a cost-effective and technically appropriate wastewater management solution for unplanned, high-density urban areas. Unlike conventional sewerage systems that require deep excavations and large-diameter pipes, the SSS design uses small-diameter, shallow-buried pipes that follow natural gradients, allowing for low-cost installation, maintenance, and community-level management. The system is planned to collect wastewater from surrounding households using 4" PVC pipes laid in shallow depth trenches. The system will operate under controlled gravity flow in accordance to designed gravity and velocity. Collected sewage will be treated at the proposed wastewater treatment facility, which is part of this project and treated effluent discharged to the adjacent river stream upon attaining required standards.

A shallow sewer system is a separate sewer system, which utilizes gravity for conveying raw sewage from all households to an outlet downstream. It must be set deep enough to receive flows from each user but must be located so that this depth is kept to a minimum. It must have sufficient size and gradient to carry these flows. In addition, maintenance operations, public safety and convenience must be evaluated in the light of water availability and the potential for user participation.

Shallow depths must be maintained not only for economy in construction but also for facilitation of user maintenance. Frequent sewer flushing, achieved through the connection to a single sewer line of a number of houses, must be ensured for good operation. Pipes with sufficient structural strength must be used, and suitable bedding materials must be selected to withstand backfilling, and impact and live loads where these are likely to occur. The type and number of appurtenances used must facilitate cleaning of the sewers with the kinds of cleaning equipment likely to be used. Public convenience and safety during construction are additional important factors.

2.5.1 Design Criteria

Conceptually, simplified sewerage is the same as Conventional Gravity Sewerage, but without unnecessarily conservative design standards and with design features that are better adapted to the local situation. The pipes are usually laid within the property boundaries, through either the back or front yards, rather than beneath the central road, allowing for fewer and shorter pipes. The project life span is estimated to be 20 years

Some of the criteria and standards for the design of the sewers are:

- Minimum velocity in pipe
- Minimum slopes of pipes
- Minimum pipe diameter
- Design peak flow factor

2.5.2 Technology Description

Layout

To avoid deep excavations, long trunk pipes to interceptors, and large pumping stations, serious consideration is given to splitting the network into two or more smaller systems. Although network layout is, also an important part of conventional design, the optimization of pipe lengths and network subdivisions takes on even greater importance in this system.

Hydraulics

Design period

Another approach to sewerage systems that can bring major benefits to the project is to reduce the design period of the sewerage system. A great advantage of using shorter-term periods is that it avoids uncertainties of population growth and reduces the high costs of maintenance of large sewer systems with low flow. Other benefits of the reduced design period are that it can also facilitate financing and achieve greater coverage with the same investment.

Design flow

Wastewater flow quantities are necessarily lower than the quantity of water supplied because water is lost through leakage, garden watering, house cleaning, etc. To determine the expected amount of wastewater, it is important to keep records of pumpage for each day and fluctuations during the day.

Where water use information is not available, the simplified sewerage system is - designed for a minimum flow of 1.5 l/s, infiltration is assumed to be 0.05-1.0 1/s/km of pipe.

Service Connection

In the simplified design, a 60-cm connection (or inspection) box is placed between the building and the service line. All the sewers or drains from the house or building enter the box. This box is usually located under the sidewalk in the public right of way. The service connection boxes will be constructed using reinforced concrete or high-density polyethylene (HDPE) materials. Reinforced concrete units will be cast using concrete of minimum strength, with steel reinforcement designed to withstand long-term structural loads and environmental exposure.

Depth of sewers

For any type of sewer connection, it is standard to have a minimum depth in which the pipes are laid should be sufficient to make house connections and have a layer of soil over the crown to protect the pipe against structural damage from external loads and frost. On simplified connections, the minimum sewer depths are usually much shallower than the conventional systems. Being as shallow as 0.65-m below sidewalks, 0.95-1.50-m below residential streets (depending on distance from the centerline of street), and 2.5-m below heavily traveled streets.

Manholes and other appurtenances

One of the most important differences between conventional and simplified sewer systems is that the former utilizes many manholes, whereas the latter type avoids its use as much as possible. The conservative criteria for manhole use contributes to the high cost of sewerage. The use of shallower depths is one way of reducing these costs.

In conventional systems, manholes are generally located at:

- The upper ends of all laterals
- Changes in direction and slope
- Pipe junctions, except building connections
- At intervals not greater than 100m for pipes up to 600mm diameter

Construction Material

The types of materials used in SSS are similar to those used in conventional sewers. The most commonly used and readily available in the market are polyvinyl chloride (PVC) pipes. Additionally, PVC pipes offer the advantage of longer sizes, fewer joints (i.e less infiltration), lightweight, water tightness and uniformity.

Table 2-1 Summary of Design Criteria

S/No	Items	Description
1	The minimum peak flow	1.5 L/s
2	The minimum self-cleansing velocity	0.5 m/s
3	The minimum gradient/slope of sewers	0.5% (1 in 200)
4	Minimum depth of block sewers	>= 40cm
5	Minimum depth of street collector sewer (Below sidewalks)	40 – 65 cm
6	Proposed pipe type	uPVC-PN6
7	Manhole type-1 for block sewers	400mm x 400mm
8	Manhole type-2 for street collector sewers	700mm x700mm

2.5.3 Waste Generation

The major wastes generation associated with the project are solid wastes and liquid waste. The solid wastes so produced will be collected and properly disposed at the collection points ready for transportation to the dumpsite.

2.5.3.1 Solid waste management

From experience point of view, households connected to the simplified sewerage system tend to throw solid wastes especially used sanitary pads into their toilet sinks thinking flushing will help but he results has always been immediate blockage.

The project design will ensure installation of garbage screen at each household level to prevent the system blockage from single individual's fault. This among others will render the household with the blockage to ensure the situation is well and timely handled at their own costs.

Therefore, solid wastes should be properly disposed at the collection points waiting for solid waste pickup trucks. Table 2-2 below shows solid and liquid wastes to be generated by the project and the methods of their disposal.

Table 2-2: Management of construction and operation wastes

Solid waste		
Type of waste	**Sources**	**Disposal / Management procedure**
Biodegradable materials mainly domestic waste (food, paper, wood etc.)	- Construction crew	Accessible litter bins within the camp site and later to the city waste disposal system (engage a private company)
Non- biodegradable materials (plastic, glass)	- Construction crew	Recycling/ reuse (Plastics to be sent to plastic recyclers and glass bottles to be sent to glass recyclers)
Liquid waste		
Type of waste	**Sources**	**Disposal / Management procedure**
- Excreta (domestic) human - Grey water /cleaners	- Toilets and floor cleaning	Use of septic tanks and when full will use the constructed Simplified sewerage system for further treatment downstream

2.5.3.2 Estimation of Wastewater Generation

Wastewater generation was estimated basing on the per capita consumption of water supply of which 80% percent is converted into wastewater. The per capita

consumption is considered as 90 liters/day as stated in the *Design, Construction Supervision, Operation and Maintenance (DCOM) Manual; Volume II Design of Sanitation Projects (4th Edition), Ministry of Water (MoW)*, *(Design Manual March 2020)* and confirmed from the household surveys conducted in each simplified sewerage site. The wastewater generated is further factored to have peak flows for pipeline design. The peak flows are used in the simplified sewerage pipeline sizing while the average daily wastewater generated is used to size the treatment units in the areas without existing treatment discharge facility.

2.6 Project Components

- Pipeline network (total length: approximately 6 km) – Smaller diameter sewer pipes (100mm) that collect wastewater from households and communal facilities.
- Manholes and inspection chambers - Maintenance and monitoring points for operations, preventing blockages.
- Household connections (estimated 300 households) - Linking household waste discharge points (toilets, greywater drains) to the main line. Where households currently use pit latrines or septic tanks, conversion works will be done to allow safe flow into the sewer.
- Wastewater treatment Plant - Sustainability and standard compliance of final effluent before discharge.

2.4 Labour Force

The labour force will be determined by the Contractor; nevertheless, it is projected that during the construction phase the project will require not less than 100 workers both skilled and non-skilled laborers for each phase of project construction.

CHAPTER THREE

3.0 POLICIES, LEGISLATION AND INSTITUTIONAL ASPECT

According to the fundamental principles of environment, any developmental activities of this nature such as construction of Simplified sewerage system would have socio-economic and somehow environmental impacts that must be addressed and governed in order to serve public interest and sustainable development. Given the many existing and developing environmental laws, regulations and standards in Tanzania, it is worth considering resorting to constitutional provisions to protect and manage the environment. With increasing environmental awareness in recent decades, the environment has become a higher political priority and many constitutions now expressly guarantee a 'right to a healthy environment', as well as the procedural rights necessary to implement and enforce the substantive rights granted. The public or national interest in this aspect is addressed through government Policies and regulated by Principal Acts and Regulations. The implementation of the proposed project shall touch various sectors; therefore, the developer has to comply with number of cross-sectorial policies and legislations relevant to this project. Also, the listed institutions involved in environmental management for the project is included in this chapter.

3.1 RELEVANT POLICIES

This section focuses on various policies which guide the development aspects for sustainable vision, apart from the national environmental policy, there are numbers of sector policies that are to be reviewed when executing the proposed development and these include;

3.1.1 National Environment Policy 1997

The National Environmental Policy of 2021 has just been launched in February 2021. The new policy formulation is a revision of the National Environmental Policy of 1997. The Policy serves as a national framework for planning and sustainable management of the environment in a coordinated, holistic and adaptive approach taking into consideration the prevailing and emerging environmental challenges as well as national and international development issues. Effective implementation of this policy requires mainstreaming of environmental issues at all levels, strengthening institutional governance, and public participation in environmental management regimes. The long-term vision of this policy is geared towards the realization of environmental integrity, assurance of food security, poverty alleviation, and increased contribution of the environmental resources to the national economy. It also recommends strong institutional and governance measures to support the achievement of the desired objectives and goals.

The policy seeks to promote the economy and livelihoods of people while promoting sustainable utilization of natural resources in the country. The policy provides the

framework for the formulation of plans, programs, and guidelines for the achievement of sustainable development.

The policy's overall objective is to provide a national framework for guiding harmonized and coordinated environmental management for the improvement of the welfare of present and future generations. The specific objectives are i) to strengthen coordination of environmental management in sectors at all levels; ii) to enhance environmentally sound management of land resources for socioeconomic development; iii) to promote environmental management of water sources; iv) to strengthen conservation of wildlife habitats and biodiversity; v) to enhance conservation of forest ecosystems for sustainable provision of environmental goods and services; vi) to manage pollution for the safe and healthy environment; vii) to strengthen the national capacity for addressing climate change impacts; viii) to enhance conservation of aquatic system for the sustained natural ecosystem; ix) to ensure safety at all levels of application of modern biotechnology; x) to promote gender consideration in environmental management; xi) to promote good governance in environmental management at all levels; and xii) to ensure predictable, accessible, adequate and sustainable financial resources for environmental management.

During implementing the project, Contracting Authority should consider the requirements of the policy including environmental protection through implementing impacts mitigation, management and monitoring plans. Henceforth the preparation of this Improved Project Brief study aims at adhering to this policy through identifying impacts, proposing mitigation, management and monitoring plans.

3.1.2 National Land Policy of 1997

The National Land Policy states that “the overall aim of a National Land Policy is to promote and ensure a secure land tenure system, to encourage the optimal use of land resources, and to facilitate broad-based social and economic development without upsetting or endangering the ecological balance of the environment”. This study partly responds to this requirement.

3.1.3 Construction Industry Policy (2003)

Among the major objectives of the policy, which supports a sustainable development in sanitation sector, including the promotion and application of cost-effective and innovative technologies and practices to support socio-economic development activities such as, sanitation, water supply, shelter delivery, and income-generating activities and to ensure application of practices, technologies, and products which are not harmful to either the environment or human health. The proposed Simplified Sewerage System Project has been designed and will be implemented in compliance with the Construction Industry Policy of 2003, which aims to promote

sustainable development of the construction sector through enhanced technology transfer, capacity building, quality assurance, and contractor accountability.
In line with the policy's provisions on technology transfer, the project will promote knowledge sharing and skills development throughout the construction phase. Contractors engaged in the project will be required to employ and train local technical personnel, including engineers, technicians, and skilled artisans, thereby enhancing practical experience in simplified sewerage construction techniques. The project emphasizes strong contractor accountability mechanisms in accordance with the Construction Industry Policy (2003). Contractors will be engaged through competitive procurement processes that ensure compliance with national registration requirements, professional qualifications, and proven experience in sanitation or civil infrastructure works.

3.1.4 National Health Policy (2003)

The health Policy is a vital guide towards health development of any country. It is particularly, important in a country like ours where resources and technology are more limited than in other countries, which are relatively better off in both technology and resources. This Policy is a revision of the 1990 Health Policy, which emphasized on the need for increasing community involvement in health development and improved access and equity in health and health services.
The Policy recognizes the challenges of consolidating the principles of the previous health policy in community involvement, improved health services provision, access and equity while addressing the different dimensions of reforms that are taking place in the Public Sector.
One of the key objectives of the National Health Policy is the prevention of communicable diseases through improved environmental sanitation. In densely populated urban areas such as Sinza D, inadequate wastewater management contributes significantly to the transmission of sanitation-related diseases including cholera, typhoid fever, dysentery, diarrhea, and other waterborne infections. The project will reduce these health risks by providing a controlled and hygienic system for wastewater collection and conveyance. By replacing reliance on poorly maintained pit latrines and overflowing septic systems, the project minimizes direct human contact with untreated wastewater, thereby interrupting major disease transmission pathways. The improved sewerage system will significantly reduce the likelihood of fecal contamination of surface runoff, open drains, and surrounding living environments, particularly during the rainy season when flooding frequently spreads pathogens within residential areas.

The National Health Policy emphasizes the importance of maintaining environmental health standards to protect community wellbeing. The proposed project contributes to this objective by ensuring that wastewater is safely conveyed away from residential areas and transported to authorized treatment facilities in accordance with national environmental and public health regulations.

3.1.5 National Gender Policy of 2000

The overall objective of the Gender and Development Policy is to promote gender equality and equal participation of men and women through facilitation of access to education, child care, and employment and decision making. Also, this policy is to provide guidelines that will ensure that gender-sensitive plans and strategies are developed in all sectors and institutions. The proposed Simplified Sewerage System Project integrates gender considerations throughout its planning, construction, and operation phases in line with the National Gender Policy, which promotes equitable participation of women and men in development initiatives and equal access to social and economic services. During the construction phase, the project will promote equal employment opportunities directly or indirectly for both women and men. Contractors will be required to apply non-discriminatory recruitment practices and ensure that women are given fair consideration for available jobs, including skilled, semi-skilled, and unskilled positions.

3.1.6 National Human Settlements Development Policy (2000)

Among the objectives of this policy is to improve the level of the provision of infrastructure and social services for the development of sustainable human settlements and to make serviced land available for shelter to all sections of the community. Such infrastructure and services constitute the backbone of urban/rural economic activities. Simplified Sewerage System is one among of the important infrastructure for the Sinza D community and country at large

3.2 PRINCIPAL LEGISLATIONS AND REGULATIONS

The ESIA team reviewed several legislations relevant to the construction of Simplified Sewerage System. These encompass Principal Acts that support and provide guidelines to implement the intended project as discussed below.

3.2.1 Environmental Management Act (2004)

Among the major purposes of the EMA are to provide the legal and institutional framework for sustainable management of the environment in Tanzania; to outline principles for management, impact and risk assessment, the prevention and control of pollution, waste management, environmental quality standards, public participation, compliance, and enforcement; to provide the basis for the implementation of international instruments on the environment; to provide for the implementation of the National Environmental Policy; to provide for the establishment of the National Environmental Fund and to provide for other related matters.

Part III, Section 15(a) states that "*in matters about the environment, the Director of Environment shall coordinate various environment management activities being undertaken by other agencies to promote the integration of environmental considerations into development policies, plans, programs, strategies projects and*

undertake strategic environmental assessments to ensure the proper management and rational utilization of environmental resources on a sustainable basis for the improvement of the quality of human life in Tanzania".

Part X of the law deals with Environmental Quality Standards. Section 140 of this act states that "*The National Environmental Standards Committee of the Tanzania Bureau of Standards established under the Tanzania Bureau of Standards Act, 1975 shall develop, review and submit to the Minister proposal for environmental standards and criteria concerning; water quality; discharge of effluent into the water; air quality; control of noise and vibration pollution; sub-sonic vibrations; soil quality, control of noxious smells; light pollution; and any other environmental quality standard*" Some of these standards have already been published in the government *gazette* while others are not in place. This project shall take into account all the standards specified by this act.

3.2.2 The Environmental Management (Fees and Charges) Regulations, 2021

These Regulations shall apply in relation to an act or service in respect of which fees and charges are payable under the Act and Regulations made thereunder. The regulations emphasize that "a person shall not, upon payment of fees and charges prescribed in the Schedule to these Regulations, carry on any of the following":

- Environmental Impact Assessment;
- Environmental Compliance Monitoring and Audit;
- Registration of Environmental Experts;
- Environmental Quality Standards;
- Noise and Vibrations; or
- other activities related to the environment

This project complies with the regulations since the proponent has already paid registration fees and review charges as directed by NEMC.

3.2.3 The Environmental Management (Control of hazardous Waste) regulations, 2021

The objective of these regulations is to protect the environment and human health by preventing or reducing the generation of Hazardous waste, the adverse impacts of the generation and management of hazardous waste and by reducing overall impacts of resource use and improving the efficiency of such use, which are crucial for the transition to a circular economy. The regulation requires that "any person generating, collecting, storing, transporting, treating, recycling, reusing, recovering and disposing of hazardous waste or any person exercising jurisdiction under these Regulations shall, assure that there are no adverse impacts to be generated or caused by the activity conducted. Project developer will comply with the requirements of this regulation by reducing the construction materials that may generate hazardous impacts, as well as proper handling of such waste such as in use of fuels for various purposes etc.

3.2.4 The Environmental Management (Control of Noise and vibration) regulations, 2015

The regulations focus on the maintenance of a healthy environment for all the people in Mainland Tanzania, the tranquility of their surrounding and their psychological well-being by regulating noise and vibration levels to prescribe the maximum permissible noise and vibration levels from a facility or activity to which a person may be exposed. The project developer will make sure that all the guidelines under this policy will be considered to ensure the healthy environment to everyone.

3.2.5 The Environmental Management (Prohibition of Plastic Carrier bags) regulations, 2019

Regulations are meant to impose a total ban on the import, export, manufacturing, sale, and use of plastic carrier bags regardless of their thickness. Plastic carrier bags has a wide definition in the Regulations, as a bag made of plastic film, with or without handles, or gussets and to which its layer is in any thickness. The Regulations also categorically state that no person shall sell or offer for sale beverages or other commodities wrapped in plastics unless the nature of such commodities require wrappings by plastics, and restricts any licensing authority from issuing any licenses after the Regulations come into force. Project developer will make sure that there will be no use of plastic bags within the project site and the whole project life time, also in case of the need of carrier bags the proponent will make sure that there will be a n alternative bags which are allowed by the regulations. For the commodities that are wrapped in plastic, then the proponent will make sure that such plastic will be handled properly.

3.2.6 The Environmental Management (Solid Waste Management) regulations, 2007

The solid waste management regulation of 2007, provides general directive on management of solid waste as follows: -

Regulation detail the requirements and responsibilities for managing solid waste in Tanzania, highlight waste minimization and cleaner production principles alongside the duty to safeguard the public health and the environment from adverse effects of solid waste. Detail permitting requirements notably that any person dealing with solid waste as collector, transporter, waste depositor or manager of a transfer station will apply to the LGA for a permit. The local authority will also issue licenses to individuals or companies qualified to operate solid waste disposal sites; permit is required to operate an LGA waste disposal site. The proposed project is expected to generate solid waste in construction phase. Therefore, to comply with this regulation the Project developer will engage the registered solid waste collection contractor.

3.2.7 The Environmental Management (Water Quality) regulations, 2009

Regulations provide for institutional and legal framework for sustainable management and development of water resources; to outline principles for water

resources management; to provide for the prevention and control of water pollution; to provide for participation of stakeholders and the public in implementation of the National Water Policy. These regulations require the sustainable management of water sources and proper use of the available sources without causing any damage towards such sources. In addition, the regulations emphasize that it is every one's responsibility to conserve and preserve the available water sources in Tanzania. During all phases of the project there will be water demand, hence the project developer will make sure that there will be a sustainable use of water. Also during construction and maintenance phase, the developer will make sure that the water supply pipes will not be damaged in either ways

3.2.8 The Environmental Management (Air Quality) regulations, 2009

The Regulations were formed in order to -

- Prohibit emissions and releases of hazardous substances into the environment
- Prescribe permissible emission limits and quantities of emissions of sulphur oxide, carbon monoxide, black smoke and suspended particulate matters, nitrogen oxide, ozone, hydrocarbons, dust and lead
- Empower NEMC to issue air pollutant emission permits, enforce compliance, undertake emergency prevention and issue stop orders
- Set baseline parameters on air quality and emissions based on a number of practical considerations and acceptable limits and ensure protection of human health and the environment from various sources of pollution.

The proposed project will adhere the requirements of this Act, emission limits will be monitored to the permissible limits.

3.2.9 The Environmental Management (Soil Quality) regulations, 2009

These Regulations, made by the Minister of State under sections 143, 144 and 230 of the Environmental Management Act, concern soil pollution and soil quality standards and provide with respect to a soil protection permit and compliance system. They also concern measures of enforcement. The object of these Regulations is to

- Set limits for soil contaminants in agriculture and habitat;
- Enforce minimum soil quality standards prescribed by the National Environmental Standards Committee.

Also, the regulations require that, the contaminants of volatile organic compounds in habitat and agricultural soils shall comply with parameters and upper limits as prescribed and contaminants of heavy metals in habitat; agricultural soils shall comply with parameters and upper limits as prescribed and contaminants of pesticides in habitat and agricultural soils shall comply with parameters and upper limits as prescribed. Local government authority may prescribe special or specific measures and guidelines for soil conservation applicable to their respective areas of

jurisdictions which are not below standards prescribed under these Regulations. The Project developer will comply with the requirements made under these regulations.

3.2.10 Occupational Health and Safety Act 2003

The provisions of this law require employers to provide decent working environment to employees to guarantee their health and safety. Occupational health and safety services are important for sustainable development of a country, as they reduce occupational accidents and diseases, which can have huge economic burden to individuals, enterprises and the nation as whole. Improving health and safety of workers will significantly increase productivity at the workplaces to encourage more investments, increase job creation, higher morale, and job satisfaction hence industrial harmony. The law also entails employers to fulfil obligations of ensuring workers use safety of the equipment and providing proper safety gears as required.

3.2.11 Water Supply and Sanitation Act No. 12 of 2019

This legislation provides for sustainable management and adequate operation and transparent regulation of water supply and sanitation services; provides for establishment of water supply and sanitation authorities as well as community owned water supply organizations; and provides for appointment for service providers. The main aim of this law is to ensure the right of every Tanzanian to have access to efficient, effective and sustainable water supply and sanitation services for all purposes by taking into account among others protection and conservation of water resources and development and promotion of public health and sanitation; and protection of the interest of customers. Under this law, the Minister responsible for water affairs shall establish water authority and cluster water authorities in order to achieve commercial viabilities. The Act emphasizes the prevention of environmental pollution and protection of public health by requiring wastewater to be safely collected, conveyed, treated, and disposed of in accordance with approved standards. This aligns directly with the objectives of the proposed project, which seeks to improve wastewater management in Sinza D and reduce environmental contamination risks.

3.2.12 Engineers Registration Act and its Amendments 1997 and 2007

The Acts regulate the engineering practice in Tanzania by registering engineers and monitoring their conduct. It establishes the Engineering Registration Board (ERB), the law requires any local or foreigner engineer to register with ERB before practicing in the country. Project developer will continue to comply as it has utilized the services of registered engineering firm for its structural designs, which it will continue to use to supervise the construction process.

3.2.13 Contractors Registration (Amendment) Act, 2008

The Contractors Registration Act requires contractors to be registered by the Contractors Board (CRB) before engaging in practice. It requires foreign contractors to be registered by the Board before gaining contracts in Tanzania. Project

Developer shall comply with the law requirement during the recruitment of contractors for project implementation.

3.2.14 Architects and Quantity Surveyors Act (1997)

The Act requires Architects and Quantity Surveyors to be involved in the project to be registered by the Architects and Quantity Surveyor Board (AQSB) before engaging in practice. It also requires foreign contractors to be registered by the Board before gaining contracts in Tanzania. Project Developer has complied with the law requirement during the recruitment of architects who have designed the project and will continue to utilize registered persons in the project implementation.

3.2.15 Urban Planning Act (2007)

The law provides for the orderly and sustainable development of land in urban areas, to preserve and improve amenities; to provide for the grant of consent to develop land and powers of control over the use of land and to provide for other related matters. Under Section 3, among others the law seeks to improve level of the provision of infrastructure and social services for sustainable human settlement development. This act established planning authorities, which include the city, municipal, town and township councils in the country, which have responsibilities including:

- Secure the orderly and environmentally sustainable development of area under its jurisdiction;
- Prepare general and detailed planning schemes;
- Control building densities and access to buildings;
- Recommending approval of building schemes and subdivision of plots by developers;
- Secure cooperation of all agencies, utility bodies, land owners and other bodies and institutions involved in the preparation and implementation of planning process;

Under the Urban Planning Act, any development activity undertaken within planned urban areas including installation of underground utilities such as sewer pipelines requires formal development approval from the relevant planning authority.

For the proposed project, underground sewerage works constitute physical development and pipe lying therefore require the following approvals:

- Building permit issued by the Local Government Authority (Ubungo Municipal Council) through the Urban Planning Department.
- Compliance with setback and reserve requirements, particularly within road corridors, public open spaces, and utility corridors, in this case the proponent has to acquire permit from TARURA, which is on progress.

3.2.16 Public Health Act (2009)

Provide for the promotion, preservation, maintenance of public health with a view to ensuring the provisions of comprehensive, functional and sustainable public health services to the public. Part III (e) of the act requires premises owners to keep their premises free of mosquitoes and other disease vectors, vermin or causative agents; Section 54 prohibits causing or suffering from nuisance likely to be injurious or dangerous to health, land, premises, air or water; Part IV (c) assigns responsibility to City council to remove or appoint an agent to collect, transport and dispose solid and liquid waste and charge fees to beneficiaries of this service and responsibilities for prescribing types of wastes and guidelines for their collection and disposal; Section 101 it gives rights to any private sewer to connect it to any available public sewer to discharge foul or storm water therefore the project may connect to and discharge sewage or storm water into the available trunk main. However, the quality of the sewage should be as per agreed with the water authority.

The Contracting Authority will ensure that the project design, construction and operation does not constitute a nuisance; meets the requirements meets public health requirements

3.2.17 World Bank guidelines for Environmental Management

The main objective of this EMP is to establish a set of mitigation and monitoring measures to minimize the adverse social and environmental impacts that can take place during the implementation stage of the subproject. The measures especially focus on sensitive receptors or sensitive locations. The EMP also provides specific information about the monitoring program during construction stage including locations, frequency and reporting process. This project complies with these guidelines as it has ESMP, which contains mitigation and monitoring plans of the identified impacts.

3.2.18 The Environmental Impact Assessment and Audit Regulations, 2005 (as amended 2018)

The Environmental Impact Assessment and Audit Regulations, 2005 (as amended 2018) serve as the primary legal instrument governing environmental assessment in Tanzania. They ensure that development projects are environmentally sound, socially responsible, and implemented in a manner that safeguards human health, ecological systems, and sustainable development objectives.

The proposed Simplified Sewerage System Project is governed by the Environmental Management Act, Cap. 191, and the Environmental Impact Assessment and Audit Regulations, 2018, as amended. These Regulations provide the legal framework for environmental assessment, screening, review, approval, implementation, and monitoring of development projects in the United Republic of Tanzania.

In accordance with Regulation 5 and Regulation 6 of the Environmental Impact Assessment and Audit Regulations, 2018 (as amended), all development projects likely to have environmental and social impacts are required to undergo environmental screening to determine the appropriate level of environmental assessment.

The proposed simplified sewerage system falls under infrastructure and urban development projects listed in the First Schedule of the Regulations, which require submission of a Project Brief to the National Environment Management Council (NEMC) for screening. Consistent with the Regulations, a Project Brief was prepared and submitted to NEMC describing the nature of the project, its location, scale, anticipated environmental and social impacts, and proposed mitigation measures. The Project Brief formed the basis for environmental screening and determination of the appropriate level of assessment. After screening the Council decided that the project requires the detailed project brief.

CHAPTER FOUR

4.1 Environmental and Social Baseline Conditions

4.2 Introduction

Understanding the existing environmental and social baseline conditions is crucial for assessing the potential impacts of the proposed Simplified Sewerage System Project in Sinza D. This section provides a comprehensive overview of the physical, biological, and socio-economic environment of the project area, serving as a reference point for impact assessment and the formulation of mitigation measures.

4.3 Physical Environment

4.3.1 Location and Topography

The project is located in Sinza D, one of the sub-wards of Ubungo Municipality in Dar es Salaam Region. Sinza D is an urban, medium-density settlement located approximately 10 kilometers northwest of the Dar es Salaam city center. The topography is relatively flat to gently undulating, with minor elevation differences that influence surface runoff and drainage. The terrain makes the area suitable for a gravity-based simplified sewer system.

4.3.2 Climate

Dar es Salaam has a tropical climate characterized by high humidity and temperature. It experiences two rainy seasons: the long rains from March to May and the short rains from October to December. Average annual rainfall is approximately 1,100 mm, and temperatures range between 25°C and 33°C. Historical

meteorological data for Dar es Salaam indicate that average annual rainfall ranges between 1,100 mm and 1,400 mm, with peak monthly rainfall occurring from March to May.

4.3.3 Geology and Soils

The geology consists of alluvial and sandy soils with low water retention capacity. These soils are moderately permeable, which affects the percolation of effluents from pit latrines and septic tanks. Uncontrolled wastewater seepage contributes to groundwater contamination in some parts of Sinza.

4.3.4 Surface Water

The Sinza River, a tributary of the Msimbazi River, flows along the eastern boundary of Sinza D. This stream plays a vital role in local drainage but is heavily affected by pollution from domestic wastewater and solid waste. Seasonal flooding along the banks is common during heavy rains, especially in areas lacking proper storm water drainage.

4.3.5 Groundwater

Most residents rely on shallow wells or boreholes for water supply. However, these water sources are often contaminated due to the proximity of pit latrines and poor sanitation infrastructure. The proposed sewerage intervention is expected to improve groundwater quality by reducing the infiltration of untreated effluents.

4.3.6 Topography and Soils

The project site lies in a relatively flat area with gentle slopes facilitating gravity flow for the sewer network. Soils in the area are sandy-clay, with moderate permeability, suitable for shallow trenching required for simplified sewer construction.

4.3.7 Air Quality

Air quality in the Sinza D project area was assessed at three representative locations (SP1, SP2, SP3) under clear cloud weather conditions. The parameters monitored include particulate matter ($PM_{2.5}$, PM_{10}), oxygen (O_2), carbon monoxide (CO), hydrogen sulfide (H_2S), carbon dioxide (CO_2), sulfur dioxide (SO_2), and nitrogen dioxide (NO_2).

Sampling Location	Weather Condition	Ambient air pollution concentrations							
		$PM_{2.5}$ ($\mu g/m^3$)	PM_{10} ($\mu g/m^3$)	O_2 (%)	CO (ppm)	H_2S (ppm)	CO_2 (ppm)	SO_2 (mg/m^3)	NO_2 (mg/m^3)
SP1	Clear Cloud	67.1	98.4	20.9	0	0	420	0.003	0.1
SP2	Clear Cloud	27.9	96.5	20.9	0	0	417	0.003	0.1
SP3	Clear Cloud	49.7	92.8	20.9	0	0	422	0.009	0.1
TZS 845:2019 Limits		75	100	19.5-23.5	10 ppm for 1 hour of exposure	20	1000	0.5 for 24hr exposure minutes	0.38 for 1 hour of exposure

Air quality in the Sinza D project area is generally within national standards (TZS 845:2019). PM_{10} levels are near the upper limit, suggesting that dust control measures should be enforced during construction activities to prevent exceedances. Continuous monitoring is recommended, particularly during the dry season and high construction activity periods, to ensure compliance and protect human health.

4.3.8 Noise Levels

The measurements and assessment of environmental noise levels were determined in accordance to ISO standards using Integrating Averaging Sound Level Meter (model **Piccolo II** (Class 2)

Sampling Location	*LA_{eq}*	*LAS_{max}*	*LAS_{min}*	*$LAS_{10\%}$*	*$LAS_{90\%}$*	*Category of Area*
SP1	68.1	75.8	60.7	71.6	63.5	Commercial
SP2	60.2	73.3	47	63.1	51.5	Commercial
SP3	59.6	72.4	48.6	62.9	51.7	Residential
SP4	62.2	73.1	50.8	66.5	53.9	Residential
SP5	69.4	82.5	51.9	72.4	53.8	Residential

Based on noise measurements taken during the daytime (10:00 AM – 14:00PM) at 5 sampling stations, the recorded levels were between 41.1 – 82.5 dBA. It was noted that the main contributor of the measured noise are vehicles, wind currents, insects and birds sound passing nearby the project site.

Tanzania Standard TZS 932:2007 stipulates maximum permissible day and night time noise levels for an industrial areas to be 85dBA and 65dBA respectively. Likewise, the stipulated TBS and IFC/WHO guidelines require noise emission levels of less than 70dBA in the working areas.

The recorded noise level at all most of the measured points was found to be below the established TBS and WHO standards. However the Background recorded noise Level (LA_{90}) shows that the noise level within and outside the vicinity of the project in the most of the sampling location is already below the Environmental Management (Standards for the Control of Noise and Vibrations Pollution) Regulations, 2014 for Residential, Commercial and Industrial Sites.

4.4 Biological Environment

4.4.1 Flora

Vegetation in Sinza D is highly modified due to urban development. Common plant species include ornamental trees, shrubs, and a few scattered fruit trees (e.g., mango, banana, and coconut). Natural vegetation is sparse, mostly confined to riverbanks and undeveloped plots. No threatened or protected plant species were

identified within the project footprint. Vegetation clearance will be minimized, and all disturbed areas will be reinstated following construction.

4.4.2 Fauna

The fauna within the project area is characteristic of an urban environment and is generally limited to species that have adapted to human presence and habitat modification. Observations and secondary sources indicate that the terrestrial wildlife primarily consists of small urban-adapted mammals, birds, rodents and insects often inhabiting residential areas, vacant lots, and drainage channels. No endangered or protected terrestrial or aquatic species were recorded within the immediate project area during field surveys. The urban-adapted species observed are generally tolerant to environmental disturbances.

4.5 Socio-Economic Environment

4.5.1 Population and Settlement Pattern

Sinza D is a mixed-income residential area with a population estimated at over 12,000 residents. Settlement patterns are dense and mostly unplanned, with houses constructed closely together. This density poses challenges for sanitation, solid waste management, and infrastructure development.

4.5.2 Land Use

The predominant land use is residential, interspersed with small-scale businesses, schools, religious institutions, and health facilities. There is limited public open space, and the road network is constrained, often unpaved and narrow.

4.5.3 Sanitation and Waste Management

Most households use pit latrines, pour-flush toilets, or septic tanks, many of which are poorly constructed or unlined. Overflow and leakage from these systems are common, contributing to surface water contamination and poor hygiene. There is no formal sewer system in the area, and faecal sludge management is largely informal.

4.5.4 Water Supply

Residents obtain water from:

- DAWASA piped water network (intermittent)
- Shallow wells
- Water vendors

Contamination of shallow wells is a concern, particularly during rainy seasons.

4.5.5 Energy Use

Most households use electricity from TANESCO for lighting, while cooking energy is primarily derived from charcoal and gas. This contributes to urban air pollution and deforestation outside the urban core.

4.5.6 Health Conditions

Common public health issues include:

- Diarrheal diseases (especially among children)
- Skin infections
- Mosquito- and fly-borne diseases

These issues are closely linked to poor sanitation and waste disposal practices.

4.5.7 Education and Awareness

Literacy rates are high, and the community generally understands the importance of sanitation. However, limited infrastructure and affordability constrain behavior change. There is potential for strong community engagement in the project, especially if linked with awareness campaigns.

4.5.8 Gender and Vulnerable Groups

Women and children bear a disproportionate burden of poor sanitation through increased health risks and time spent managing household hygiene. Vulnerable groups (e.g., the elderly, disabled, and low-income families) often have limited access to safe sanitation.

4.5.9 Infrastructure and Utilities

Sinza D is integrated within Dar es Salaam's utility network. Electricity is widely available through TANESCO's national grid, although power outages are still common. Telecommunication services are available, with 3G/4G mobile networks covering the area. The road network comprises narrow, unpaved community roads that are often congested and prone to erosion during rains. Solid waste management services are inconsistent, leading many residents to dump waste in drains or open spaces. Storm-water infrastructure is underdeveloped, with most drains either blocked or poorly designed. The existing infrastructure conditions demand a careful design approach that minimizes disruption during project implementation.

CHAPTER FIVE

5. STAKEHOLDERS ENGAGEMENT

5.1 Introduction

Stakeholder engagement is a crucial part of the Environmental and Social Impact Management to ensure transparency, social acceptability, and community ownership of the Sinza D Simplified Sewerage Project. The engagement process follows World Bank Environmental and Social Standard 10 (ESS10) and national guidelines on public participation.

5.2 Objectives of Stakeholder Engagement

- To identify and involve stakeholders affected or likely to be affected by the project
- To collect concerns, feedback, and expectations from stakeholders
- To inform stakeholders about project scope, impacts, and mitigation measures, grievance management, compensation etc
- To ensure stakeholder views are integrated into project design and implementation

Table 5-1 Key Stakeholders Identified

Stakeholder Group	Relevance
Sectoral Stakeholders – National-wise	
Ministry of Water (MoW)	Policy oversight and coordination
NEMC (National Environmental Management Council)	Regulatory and environmental compliance oversight
Institutional Stakeholders	
DAWASA	-Water and sanitation service provider. - Project Implementing agency responsible for design, construction, and operation
Local Stakeholders	
Local Government Authorities (Kinondoni Municipality)	Land use, local infrastructure, grievance resolution
TARURA	Access and right of way permits
Local community members (residents of Sinza D)	Project beneficiaries
Local leaders (Mtaa & Ward leaders)	Represent community interests and mediate communication They are the key players as they link DAWASA, Contractor and other ect with the community
Community-Based Organizations (CBOs)	Local sanitation promotion and awareness -Environmental preservation

5.3 Methods of Engagement

- Public Consultative Meetings held at community centers in Sinza D whereby the public meeting was conducted at Sinza D office
- Key Informant Interviews with local leaders and institutions

5.4 Stakeholders meeting

The stakeholder engagement process is a critical component of the ESMP, ensuring that the project is socially inclusive, environmentally responsive, and locally accepted. The stakeholder's engagement meeting was conducted on 23rd May 2025, and 24 people were consulted of which women were 5 and rest is men, whereby the meeting minutes were recorded and attached in this report together with photos as appendix iii:

5.4.1 Overall Community Reception and Feedback

The overall reception of the proposed Simplified Sewerage Project in Sinza D was strongly positive across all stakeholder groups. This enthusiasm was based on both the perceived long-term benefits and the experience of past sanitation challenges in the area. Generally, the Sinza D community expressed positive support for improved sanitation but asked for assurance that fees or connection costs would be fair and affordable. However some of the concerns and views about the project areas presented in table 1-7

- Widespread Support: Community members generally welcomed the project as it addressed long-standing sanitation challenges, especially frequent sewage backups, latrine overflows during rainy seasons, and groundwater pollution.
- Desire for Connection: Many property owners expressed readiness to connect to the simplified sewer network, citing reduced costs for pit latrine emptying and improved neighborhood hygiene.
- Pride in Modernization: Participants voiced a sense of pride in being selected for a modern sanitation solution.
- Confidence in Improved Living Standards whereby the project will leads to increased property values, which will be attractive for new tenants. *"With proper sewerage, we can finally attract better tenants. This project will improve our properties.*
- Reduced latrine maintenance costs.

Table 5-2 Summary of Stakeholder Views and Responses

Name of the Stakeholder	Issue Raised by Stakeholders	Project Response / Action
Ubungo Municipal **(Environmental Officer)**	The Proposed SSS project is of great benefits to Sinza D community and the Ubungo Municipal at large as it will improve sanitation The project will reduce outbreak of diseases that might occur due to poor sanitation The project will reduce cost for emptying the septic tanks Continuous awareness to the community about the project	DAWASA will coordinate with CBOs and LGAs for community sensitization campaigns
Ubungo Municipal (Town Planning Officer)	The proposed project will improve environmental conservation There is no any land issue	

TARURA Ubungo	DAWASA have already applied for the permit from TARURA to use the reserve area along the road network Currently there is the ongoing project for improving the existing roads in Sinza, Therefore the contractor and DAWASA are requested to cooperate	The chambers and manholes will be covered to avoid odor
Sinza Ward & Sinza D Mtaa	The proposed project will reduce the existing problem of grey-water discharge from some of the households Employment opportunities to the local community especially the Youth in Sinza D area The project will improve the sanitation status in Sinza D area. Is there any bad smell produced from the proposed project? Who is responsible to solve any issue concerning project after the project is completed	Local Community will be first priority for employment opportunities All Chambers and manholes will be covered There will be grievance redress committee
Sinza Community	Who is responsible to solve any issue concerning project after the project is completed	There will be Grievance Redress committee which will also include members from the community, NGos and Local Government leaders. This GRM Committee will be responsible to register grievances and provide solution.
	Who will be responsible for our grievances Disruption of utilities like safe water pipes	There will be Grievance Redress committee which will also include members from the community, NGos and Local Government leaders. This GRM Committee will be responsible to register grievances and provide solution. The utilities and infrastructures will be maintained and prior notifications will be provided

		so that the community is aware.
	Concerns over temporary access disruption to homes and businesses	Construction will be phased and signage provided; temporary access will be maintained
	Risk of foul odors during operation	The chambers and manholes will be covered to avoid odor
	Worry about system failure	The project was already implemented in other areas and no any failure Grievance redress system will be active
	Requests for employment opportunities for locals	Local labor will be prioritized during construction and operation
	Questions about storm water drainage and possible flooding	Drainage provisions are integrated into the design; storm water will be safely diverted
	Fear of vector breeding (mosquitoes, rodents) around the system	Proper covers, drainage, and regular maintenance will be ensured to prevent stagnation
	Need for hygiene education and post-connection support	DAWASA will coordinate with CBOs and LGAs for community sensitization campaigns

CHAPTER SIX

6.1 POTENTIAL ENVIRONMENTAL IMPACTS

6.2 Environmental Impacts

6.2.1 Soil Erosion and Sediment Runoff

The excavation of trenches, movement of heavy equipment, and clearance of vegetation during the construction phase will expose soil surfaces to erosion, especially during the rainy season. The disturbed topsoil can be easily washed away, leading to sedimentation in nearby drainage systems. This runoff may cause clogging of storm-water infrastructure and affect the local hydrological balance. If not controlled, sediment-laden water may affect downstream water users and aquatic habitats.

6.2.2 Dust and Air Pollution from Excavation

Excavation activities during the construction phase will release fine particulate matter (PM10 and PM2.5) into the air, particularly in dry weather. The operation of excavators, trucks, and other machinery will exacerbate dust levels, reducing air quality and potentially causing respiratory irritation for nearby residents, especially

children and the elderly. The impact is likely to be felt most in areas with high pedestrian or roadside vendor activity.

6.2.3 Storm-Water Accumulation

Open trenches for sewer installation may accumulate storm-water during rainfall events. This not only slows construction work but also creates safety hazards and breeding grounds for disease vectors. Standing water in trenches increases the risk of trench collapse and delays in project timelines, while also possibly contaminating nearby areas with silt or construction waste.

6.2.4 Improper Solid Waste Disposal

Construction activities will generate various forms of solid waste, including packaging materials, unused pipes, concrete debris, and vegetation from cleared areas. If this waste is not properly segregated and disposed of in licensed landfills, it can be dumped along roads or in open spaces, leading to pollution and public nuisance. The accumulation of waste in residential or commercial areas may lead to visual degradation and attract pests.

6.2.5 Odor Emissions from Sewer and Manholes

During the operational phase, manholes and sewer lines may emit foul odors due to the anaerobic decomposition of organic matter. This is a common challenge in simplified sewer systems if ventilation or flow is inadequate. Odors can cause discomfort to residents, lower the aesthetic value of the neighborhood, and in severe cases lead to community complaints or resistance to sewer use.

6.2.6 Water Contamination down-streams

If construction materials, oil, silt, or untreated sewage enter nearby surface water bodies, it can degrade water quality and harm aquatic life. Discharges from broken pipes or illegal connections during operation can also introduce biological contaminants into rivers or open drains. This poses a risk to downstream users who depend on water for domestic or irrigation purposes.

6.2.7 Sludge Handling Risks during Desludging

Desludging activities, when manholes or blocked pipes are cleaned, may expose workers and the public to pathogens, offensive odors, and contaminated sludge. Without appropriate equipment and procedures, there is a risk of environmental contamination and occupational health hazards. Improper disposal of collected sludge can also cause significant environmental problems. Exposure pathways are as tabulated here under

Activity	Exposure Pathway	Potential Risk
Manual emptying and transport	Direct skin contact, inhalation of aerosols, accidental ingestion	Gastrointestinal infections, skin rashes, respiratory irritation
Storage in holding tanks or pits	Aerosol generation, leachate contamination of soil and groundwater	Waterborne diseases, contamination of local water sources
Treatment (dewatering, composting)	Dust and bioaerosol release	Respiratory infections, allergic reactions
Disposal (land application, landfill)	Contact with soil or crops, leachate migration	Soil contamination, pathogen transfer to humans and livestock

6.2.8 Improper Disposal of Construction Waste and Materials

Beyond basic solid waste, construction often produces inert but bulky materials such as broken tiles, stone, metal cuttings, and old pipes. If these are dumped in unauthorized locations such as open plots, drains, or roadsides, they may hinder pedestrian and vehicular movement, increase urban blight, and contribute to drainage blockages.

6.2.9 Site Degradation and Soil Compaction

Heavy construction equipment frequently passing over specific areas may compact the soil, reducing its porosity and natural drainage capacity. This degradation can affect vegetation growth and increase surface runoff. In the long term, it can reduce the land’s usability for landscaping or redevelopment and contribute to minor flooding.

6.2.10 Dust and Air Pollution

As trucks and machinery exit the construction zone, they carry loose soil and mud onto adjacent roads. As this dries, vehicular traffic re-suspends the dust, increasing airborne particles. This contributes to poor air quality, visibility issues, and may result in community complaints, especially in commercial areas.

6.3 Social Impacts

6.3.1 Temporary Disruption of Access to Homes and Businesses

During construction, trenching across roads, footpaths, or building entrances may limit access for residents, shopkeepers, customers, and service providers. This temporary inconvenience can disrupt daily routines, reduce foot traffic to businesses,

and create frustration among community members. In areas with narrow roads and no alternate paths, the disruption may be more severe and prolonged.

6.3.2 Increased Traffic and Road Safety Risks

The presence of construction vehicles, equipment, and materials along local streets may obstruct normal traffic flow and increase the risk of road accidents. Pedestrians, especially children and the elderly are more vulnerable in zones where there is poor signage, narrow passageways, or nighttime activities without adequate lighting. Construction near schools, health facilities, or marketplaces heightens the danger.

6.3.3 Land Use Conflicts and Boundary Disputes

Installation of sewer lines often passes close to or within property boundaries. In densely populated areas like Sinza D, any lack of clarity in alignment may lead to disputes among neighbors or between the contractor and residents. In areas where property ownership is informal or undocumented, this risk becomes even more pronounced, potentially stalling construction.

6.3.4 Risk of Encroachment on Private Property

Some sections of the project may inadvertently extend into private or disputed land due to alignment errors or space constraints. This can lead to community tension, damage to private assets (e.g., fences or gardens), and formal complaints. Encroachment also exposes DAWASA and contractors to potential legal liabilities and delays.

6.3.5 Displacement or Relocation (if applicable)

In areas where trenching or infrastructure installation requires significant space, there is a risk that temporary or semi-permanent structures such as kiosks or informal housing may be removed or relocated. Even short-term displacement can result in economic loss or emotional distress for affected households or business owners.

6.3.6 Public Health Risk Due to Inadequate Sanitation

During construction, temporary disconnection or interruption of sanitation services may occur. Additionally, improper handling of existing waste, exposure to sewage during manhole works, or stagnant water in open trenches can heighten the risk of disease outbreaks such as cholera or typhoid. Vulnerable groups, especially children, are at increased risk of exposure to harmful pathogens.

6.3.7 Inequitable Service Access

Some households, especially those located in informal or densely packed zones, may not be connected to the simplified sewer network due to physical or design limitations. This creates a sense of exclusion, especially if neighbors benefit while others are left out, potentially reinforcing local grievances or opposition to the project.

6.3.8 Community Safety Risks from Leftover Materials and Open Pits

Unattended pits, exposed pipes, and construction debris left in residential areas can create safety hazards for both children and adults. Slips, trips, and falls are common, especially during evening hours or in areas without adequate fencing. Community members may also use trenches as shortcuts, increasing accident risks.

6.3.9 Disruption of Normal Access

The movement and parking of machinery can obstruct walkways, roads, or compound entrances. For people with disabilities or parents with small children, this can be especially challenging. Emergency service access (e.g., ambulances, fire trucks) may also be temporarily hindered.

6.3.10 Community Dissatisfaction Due to Poor Site Restoration

If the site is not restored to its original or acceptable condition after construction for example, unleveled ground, broken pavements, or unplanted grass residents may perceive the project as incomplete or careless. This can reduce community support and hinder future DAWASA activities in the area.

6.3.11 Loss of Temporary Employment for Casual Laborers

While the project may create short-term job opportunities during construction, casual laborers often face abrupt contract termination after completion. This loss of income, particularly in economically vulnerable communities, can cause financial hardship and disappointment, especially if no alternative livelihood options are provided.

6.4 Project Alternatives

Introduction

The analysis of project alternatives is a critical element of environmental and social assessment. It ensures that the selected option achieves project objectives while minimizing environmental and social risks. For the Sinza D Simplified Sewerage Project, several alternatives were considered, including the "no-project" option, different locations, and different technology options.

6.4.1 Alternative 1: No Project Scenario

- **Description**: This option assumes that no intervention is made in Sinza D to address poor sanitation.
- **Implications**:
    - Continued reliance on unsafe on-site sanitation (e.g., poorly constructed pit latrines)
    - Increased risk of groundwater contamination and surface water pollution
    - Higher prevalence of waterborne diseases
    - Social and environmental degradation in a growing urban area
    - No project alternatives will promoted higher risk on public health as well as increase cost for emptying toilets and disposal of fecal sludge for Sinza D community as well as increase rate of open discharge.

This option does not address urgent sanitation needs or public health risks.

6.4.2 Alternative 2: Conventional Sewerage System

- **Description**: Full-scale underground sewerage infrastructure with centralized wastewater treatment.
- **Advantages**:
    - Long-term sanitation solution
    - Supports dense urban populations
- **Disadvantages**:
    - High capital and maintenance cost compared to Simplified sewerage system which is more affordable considering the nature and income level of Sinza D community
    - Major land and road excavation required (leading to greater environmental and social disruption)
    - Not economically viable for low-income or informal urban settings

Not cost-effective or appropriate for the local socio-economic context.

6.4.3 Alternative 3: Simplified Sewerage System in a Different Location

- **Description**: Implement the simplified sewerage system in another urban ward instead of Sinza D.
- **Considerations**:
    - Several areas in Dar es Salaam face similar sanitation challenges
    - However, Sinza D was prioritized based on:
        - High population density
        - Frequent flooding and poor sanitation indicators
        - Availability of topographical gravity flow
        - Sinza D demonstrated the most urgent need.
        - The proposed site is accessible compared to other areas and the need or demand is high considering the existing situation in Sinza D where the open discharge rate is high.

Table 6-1 Technology Alternatives

Option	Summary
Septic tanks with soak pits	Widely used but prone to overflow and groundwater contamination in dense areas
Simplified sewerage with decentralized treatment	Low-cost, effective, adaptable to urban settings
Vacuum sewerage system	High-tech and expensive, complex O&M
On-site bio-digesters	Good for individual homes but lacks communal integration

6.5 Justification for Preferred Alternative

The chosen simplified sewerage system in Sinza D offers the best balance between cost, environmental protection, health benefits, and social acceptance. It allows for inclusive urban sanitation improvement with minimal displacement or disruption while aligning with Tanzania's National Sanitation Strategy and World Bank safeguard requirements.

CHAPTER SEVEN

7.1 ENVIRONMENT AND SOCIAL MITIGATION MEASURES

7.2 Environmental Mitigation Measures

7.2.1 Soil Erosion and Sediment Runoff

- Use of silt fences and sediment traps around disturbed areas to capture runoff before it enters nearby drains or waterways.
- Schedule excavation activities during dry seasons where possible, to reduce rainfall-related erosion.
- Vegetate or stabilize exposed soil quickly after pipe installation to prevent long-term erosion risks.

7.2.2 Dust and Air Pollution from Excavation

- Regular water sprinkling on exposed soil and during trenching activities to suppress dust, especially during dry and windy days at list twice a day and water will be sourced from DAWASA.
- Covering of loose construction materials such as sand and cement during storage and transport.
- Routine maintenance of equipment to reduce exhaust emissions and ensure compliance with emission standards.

7.2.3 Storm-Water Accumulation in Trenches

- Design temporary drainage systems or diversion channels around excavation sites to prevent water accumulation.
- Cover open trenches at the end of the day or during rainfall forecasts to limit water inflow.
- Pump out accumulated water immediately and dispose it safely to avoid stagnation and construction delays.

7.2.4 Improper Solid Waste Disposal

- Sort and classify construction waste at source for appropriate reuse, recycling, or disposal. To achieve this there must be separate bins as per type of the waste.
- Engage licensed waste collection companies to regularly collect and dispose of waste to approved landfills.
- Provide covered, labeled bins onsite to encourage orderly waste disposal by workers and contractors.

7.2.5 Odor Emissions from Sewer and Manholes

- Ensure adequate ventilation and gradient in the sewer design to maintain flow and reduce anaerobic conditions.
- Use odor-trapping manhole covers or bio-filters in odor-prone zones.
- Schedule regular maintenance and flushing of lines to prevent blockages and buildup of decomposing matter.

7.2.6 Water Contamination in Nearby Streams or Rivers

- Establish a buffer zone between active construction and water bodies to prevent direct discharge.
- Store fuel, cement, and chemicals away from water channels with appropriate secondary containment.
- Train workers on spill response and deploy spill kits on-site for quick containment of any leakages.

7.2.7 Sludge Handling Risks During Desludging

- Provide appropriate PPE (e.g., gloves, masks, and boots) to desludging staff and ensure proper hygiene practices. It is advised that high-quality gear including waterproof, arm-length gloves with good grip, rubber boots, face shields or goggles, and respirators should be mandated rather than just general, lower quality protective gear
- Use mechanized desludging equipment to reduce direct contact with sludge.
- Dispose of sludge at authorized treatment or disposal sites and never in open land or water bodies.

7.2.8 Improper Disposal of Construction Waste and Materials

- Implement a site waste management plan (WMP) outlining clear procedures for collection, sorting, and disposal.
- Avoid stockpiling construction debris near drains or public spaces to reduce pollution and safety hazards.
- Recover and reuse suitable materials (e.g., broken concrete or steel) where feasible in backfilling or site restoration.

7.2.9 Oil and Fuel Leaks during Machinery Removal

- Use drip trays and containment mats during machinery fueling or maintenance.
- Inspect all machinery regularly for leaks and repair them promptly.
- Train workers on environmental handling of fuels and lubricants and clean up small spills immediately.

7.2.10 Site Degradation and Soil Compaction

- Designate specific equipment movement paths and storage areas to reduce widespread compaction.
- Avoid operating heavy machinery on wet soils to prevent deep soil structure damage.
- Loosen compacted soil and replant vegetation after works to restore site integrity and drainage function.

7.2.11 Dust and Air Pollution from Machinery Exit

- Install wheel-washing stations at site exits to clean mud and dust from vehicles before entering public roads.
- Sweep or clean nearby roads regularly to remove construction-related dirt.
- Cover loaded trucks with tarpaulins to prevent material from being blown off during transport.

7.3 Social Mitigation Measures

7.3.1 Temporary Disruption of Access to Homes and Businesses

- Prepare and implement a traffic and access management plan to ensure alternative footpaths and road detours are provided during trenching.
- Engage local leaders and residents in advance to inform them about the timing and duration of access disruptions.
- Schedule works during off-peak hours or weekends for areas with high business activity to reduce impact.

7.3.2 Increased Traffic and Road Safety Risks

- Install warning signs, reflectors, and barricades around active construction zones to alert motorists and pedestrians.
- Assign traffic marshals to guide vehicles and pedestrians near construction sites, especially during equipment movement.
- Limit construction traffic during school opening and closing hours to protect children and reduce congestion.

7.3.4 Land Use Conflicts and Boundary Disputes

- Conduct detailed site surveys and community mapping before excavation begins to avoid misunderstandings over boundaries.
- Ensure clear communication between the contractor, DAWASA, and affected residents regarding the final alignment of works.
- Involve ward land officers and street-level leadership to mediate disputes and provide verification where ownership is unclear.

7.3.5 Risk of Encroachment on Private Property

- Mark project boundaries and trench limits visibly before works begin, using temporary fencing or ropes.
- Train contractors and field teams to respect private property and avoid using personal land as storage or working areas.
- Establish a grievance redress mechanism for community members to report and resolve encroachment issues promptly.

7.3.6 Public Health Risk Due to Inadequate Sanitation

- Ensure proper containment of sewage and wastewater during manhole repairs or pipe replacements.
- Install warning signage around risky zones, and restrict public access to open trenches and waste areas.
- Provide mobile toilets and hygiene stations for workers and temporary sanitation alternatives for affected households.

7.3.7 Inequitable Service Access

- Ensure the project design includes maximum possible coverage, especially for low-income or informal households.
- Provide low-cost connection programs or financing plans for marginalized residents.
- Engage communities in participatory planning to avoid excluding any neighborhoods from the network.

7.3.8 Community Safety Risks from Leftover Materials and Open Pits

- Close or backfill open pits promptly after pipe laying to reduce risk of accidents.
- Store materials securely and away from pedestrian routes, and regularly clean the site.
- Install temporary fencing or barriers around deep trenches, especially in high-traffic or residential areas.

7.3.9 Disruption of Normal Access

- Designate specific machinery parking and unloading zones away from entrances, schools, or clinics.
- Schedule equipment movement during daytime hours only, and avoid peak foot traffic times.
- Use ramps and walkways to maintain access to key buildings or crossing points during construction.

7.3.10 Community Dissatisfaction Due to Poor Site Restoration

- Include site rehabilitation in the contractor's performance contract, with clear penalties for non-compliance.
- Reinstate roads, walkways, and green spaces to their pre-construction condition or better, including planting grass or resurfacing pavements.
- Conduct final site inspections with local leaders and residents to confirm satisfaction before closure.

7.3.11 Loss of Temporary Employment

- Notify casual workers in advance of contract end dates and provide letters of recommendation or certificates of participation.

- Collaborate with local authorities and NGOs to explore job matching or skill training programs post-project.
- Prioritize local hiring and fair wages during the project to maximize community benefit.

CHAPTER EIGHT

8.1 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN

8.2 Specific environmental and Social Management Plan

The Environmental and Social Management Plan (ESMP) presents the implementation schedule for the proposed mitigation measures to both environmental and social impacts as well as planning for long-term monitoring activities. The ESMP also includes the associated environmental costs needed to implement the recommended mitigation measures. The engineering designs have already included some of the mitigation measures recommended in this report. For instance, the use of shallow, small-diameter sewer pipes minimizes the need for deep excavations, thereby reducing risks of soil erosion, landscape disturbance, and property damage. Additionally, routing the pipes along road reserves and rear plot boundaries helps avoid major roads and private properties, which in turn reduces traffic disruptions and eliminates the need for relocation or compensation. Additional recommendations are provided in the ESMP to enable the proposed facilities become more environmentally friendly. The implementation steps will involve DAWASA, the contractor, Ubungo Municipal Council, some utilities providers such as TANESCO, and the local communities at large. Table 7-1 provide the ESMP for the proposed construction of Simplified Sewerage System to be constructed at Sinza D Street, Sinza Ward, and Ubungo Municipality.

Table 8-1 Environmental and Social Management Plan for Proposed construction of Simplified Sewerage System to be constructed at Sinza D Street, Sinza Ward, Ubungo Municipality

Environmental Impacts

Project Phase	Environmental Impact	Mitigation Measure	Responsible Party	Budget (TZS)
Construction	Soil erosion and sediment runoff	Immediate backfilling after pipe laying. Implement slope stabilization in areas with elevation.	Contractor	5,000,000
	Dust and air pollution from excavation	Water sprinkling, cover trucks transporting construction materials, limit vehicle speeds	Contractor	3,000,000
	Storm-water accumulation in trenches	Timely backfilling, dewatering, use of drainage channels	Contractor	3,000,000
	Improper solid waste disposal	Segregation, safe storage, and disposal at DAWASA-approved landfill	Contractor	2,000,000
Operation	Odor emissions from sewer and manholes	Use sealed manholes, regular maintenance and odor control chemicals	DAWASA	2,000,000
	Vector breeding (insects/rodents)	Regular inspection, larviciding, and cleanliness of manholes and chambers	DAWASA	2,000,000
	Water contamination in nearby streams or rivers	Ensure treatment compliance, sample effluent regularly	DAWASA	5,000,000

	Sludge handling risks during desludging	Use licensed contractors, follow sludge handling protocol	DAWASA, Contractor	2,000,000
Demobilization	Improper disposal of construction waste and materials	Remove all construction debris and dispose at designated DAWASA/municipal waste facilities	Contractor	3,000,000
	Oil and fuel leaks during removal of machinery	Use drip trays, drain fluids before removal, and manage hazardous waste properly	Contractor	3,000,000
	Site degradation and soil compaction	Restore site with topsoil, plant grass/vegetation, and re-grade to natural slope	Contractor, DAWASA	4,000,000
	Dust and air pollution from machinery exit	Use water sprinkling, regulate vehicle movement	Contractor	2,000,000
	TOTAL			**30,000,000**

Social Impacts

Project Phase	Social Impact	Mitigation Measure	Responsible Party	Cost (TZS)/Yaer
Construction	Temporary disruption of access to homes/businesses	Notify residents, create temporary paths, conduct phased construction	Contractor, DAWASA	4,000,000
	Increased traffic and road safety risks	Develop and enforce a Traffic Management Plan (TMP), use trained marshals - Install the informative signs ie. Construction in progress, diversion etc as well as speed limit signs	Contractor	1,000,000
Construction	Land use conflicts and boundary disputes	Community engagement, verify land ownership, conflict mediation Conduct participatory route planning, avoid private land, clearly mark construction limits, involve local leaders	DAWASA, Local Govt	2,000,000
	Risk of encroachment on private property	Demarcate alignment properly, avoid private land unless compensated	DAWASA, Contractor	1,000,000
	Displacement or relocation (if applicable)	Identify affected persons, follow World Bank ESS5 guidelines, provide compensation	DAWASA, MoW	3,000,000
	Public health risk due to inadequate sanitation	Provide clean mobile toilets and hygiene facilities for workers	Contractor	2,000,000

	Public dissatisfaction over odors or poor service	Implement O&M plan, community feedback mechanisms, hotline for complaints	DAWASA	1,000,000
	Inequitable service access (non-connection issues)	Community outreach and support for connections for vulnerable households	DAWASA, Local Government	1,000,000
Demobilization	Community safety risks from leftover materials and open pits	Secure open areas during demobilization, remove leftover tools, backfill all excavations completely	Contractor, DAWASA	2,000,000
	Disruption of normal access (e.g., from machinery/equipment)	Schedule equipment removal during off-peak hours and inform local residents	Contractor	1,000,000
	Community dissatisfaction due to poor site restoration	Conduct joint site inspections with community reps before handover; sign off with Ward leadership	DAWASA, Local Government	2,000,000
	Loss of temporary employment for casual laborers	Provide notice and pay dues; link workers with other projects or refer to labor programs	Contractor	1,000,000
	TOTAL			**20,000,000**

CHAPTER NINE

9.1 ENVIRONMENTAL AND SOCIAL MONITORING

Monitoring of the anticipated environmental and social risks and impacts in the receiving environments is important. It helps in determining the effects of the project activities on the environments enhancing understanding of cause effect relationships between human activities and environmental changes, and verifies the accuracy of prediction about the environmental impacts. It ensures compliance with regulatory measures and understanding the degree of implementation of EPM and its effectiveness. The monitoring results are also used extensively during the environmental auditing.

The Tanzanian EIA regulations require the developer to prepare and undertake a monitoring plan and conduct regular auditing. Monitoring is needed to check if and to what extent the impacts are mitigated, benefits enhanced and new problems addressed. Recommendations for monitoring have been included in the ESMP (Table 1.2). The ESMP also assigns responsibilities for monitoring activities. However, the divisional/ward/village environmental committees and municipal environmental committee will participate in the long-term daily monitoring of the project, especially during operation.

9.2 Monitoring Parameters

The selection of the parameters to be monitored is based on the high likelihood of occurrences of the selected parameters. Monitoring of these parameters will be done in various stages of the project as follows.

- Pre-construction stage – Monitoring of the parameters at this stage is meant to establish the baseline information of the target parameters in the project area.
- Construction stage - Monitoring at this stage is meant to establish the pollution levels that arise from the construction activities.
- Operation stage - Monitoring at this stage is meant to check on the impacts that might arise as a result of normal use of the infrastructure.
- Decommissioning - Decommissioning is not anticipated in the near future. However, if this were to happen, it may entail a change of use (functional changes) or demolition triggered by the change of land use.

1.

Table 9-1 Environmental and Social Monitoring Plan for Proposed construction of Simplified Sewerage System to be constructed at Sinza D Street, Sinza Ward, Ubungo Municipality

Construction Phase – Environmental Impacts

Phase	Impact	Parameter to Monitor	Frequency	Method/Standard	Responsible Party	Budget (TZS)
Construction	Dust pollution	PM10, PM2.5 (µg/m³)	Weekly	Air sampler/real-time monitors	Contractor, DAWASA	5,000,000
	Noise pollution	Noise levels (dB)	Weekly, peak hours	Sound level meter (ISO 1996)	Contractor	3,000,000
	Soil erosion/siltation	Sediment load, visible runoff	After rain, monthly	Site inspection, turbidity testing	Contractor	2,000,000
	Storm-water management	Standing water, drainage flow	Monthly	Visual inspection, checklist	Contractor	1,500,000
	Solid waste generation	Waste volume (kg), disposal records	Monthly	Waste audit and disposal records	Contractor	1,000,000
Operation	Odor emissions	H_2S (ppm), complaints	Monthly	Gas detector, community survey	DAWASA	4,000,000
	Vector breeding	Insect count, larval sites	Monthly	Field observation	DAWASA	2,500,000
	Effluent discharge	TDS, COD, BOD,	Monthly	Laboratory water	DAWASA	10,000,000

	to river	Salinity		sampling (ISO 5667)		
	Groundwater contamination	Nitrates, E. coli	Quarterly	Borehole/well sampling	DAWASA	8,000,000
	Sludge handling	Sludge volume, storage logs	Every desludging cycle	Record review and field inspection	DAWASA	3,000,000
Demobilization	Site restoration and cleanliness	Visual inspection	End of project	Site checklist and photo records	Contractor	2,000,000
	Leftover waste or debris	Waste volume (kg)	Once at closure	Waste audit	Contractor	1,500,000
	TOTAL					**43,500,000**

SOCIAL MONITORING PLAN

Construction Phase – Social Impacts

Phase	Impact	Parameter to Monitor	Frequency	Method	Responsible Party	Budget (TZS)
Construction	Access disruption	Number of affected households	Weekly	Site walkover, community reporting	Contractor, DAWASA	2,000,000
	Land/property disputes	Complaints filed	As they arise	Grievance log review	DAWASA, Local Government	1,000,000

	Worker health and safety	PPE use, incidents reported	Weekly	Observation and records	Contractor	3,000,000
	Traffic safety	Near misses/incidents	Weekly	Traffic log, police reports	Contractor	2,000,000
Operation	Community complaints (odor, service)	Complaints logged	Monthly	Feedback hotline and records	DAWASA	1,000,000
	Access to service	Number of households connected	Quarterly	Household survey, service records	DAWASA	2,500,000
Demobilization	Worker demobilization	Employment closure records	At project close	Staff exit documentation	Contractor	1,000,000
	Outstanding grievances	Resolved/unresolved cases	Once at closure	Review of grievance log	DAWASA	1,500,000
	TOTAL					**14,000,000**

Table 9-2 Potential Risk Due proposed Project

Risk Description	Phase	Category	Likelihood	Impact Severity	Mitigation Measures	Status/Notes
Storm water infiltration into excavations or sewer lines	Construction / Operation	Environmental	Medium	High	Provide temporary storm water channels and permanent diversion structures	Monitor during rainy season
Odor emissions from manholes or treatment structures	Operation	Environmental	Medium–High	Medium	Proper sealing, venting systems, regular desludging	Community hotline to report
Leaks or overflows leading to water contamination	Operation	Environmental	Medium	High	Regular inspection, flow regulation, quick repair protocols	Include in monthly inspections
Unsafe sludge handling and disposal	Operation	Environmental	High	High	Use of licensed disposal sites, PPE for handlers, and trained staff	Include in O&M training
Soil or groundwater contamination from abandoned infrastructure	Decommissioning	Environmental	Low	Medium	Decommission with removal plan and site rehabilitation	Review needed before closure
Temporary access blockage to homes/businesses	Construction	Social	Medium	Medium	Phased construction, signage, and access planks	Ongoing communication with residents
Community resistance or complaints due to poor engagement	All phases	Social	Medium	High	Regular community meetings, functional GRM	Stakeholder records maintained
Land disputes or encroachment during pipeline laying	Construction	Social	Medium	High	Coordinate with local land office, update way leaves	Ensure legal records available
Health risks to workers or community from desludging	Operation	Social	High	High	Provide PPE, hygiene training, and safe disposal systems	Monthly health checks required
Worker misconduct or GBV in community	Construction	Social	Medium	High	Enforce Code of Conduct, GBV response protocols	To be included in induction training

9.3 ESMP Implementation

9.3.1 Institutional Arrangements

The implementation of the Environmental and Social Management Plan (ESMP) for the Sinza D Simplified Sewerage Project will involve multiple institutions at various levels, led by the Ministry of Water (MoW) and implemented by DAWASA under the Off-grid Sanitation Project funded by the World Bank. Coordination between environmental authorities, contractors, local government authorities (LGAs), and community stakeholders is critical for success.

9-3 Roles and Responsibilities

Institution	Role in ESMP Implementation
Ministry of Water (MoW)	• Provides policy oversight and ensures ESMP aligns with national and World Bank standards • Supervises DAWASA and ensures safeguard compliance • Compile national-level reports on project performance, including environmental and social safeguards, to be shared with the World Bank and other partners.
DAWASA (Implementing Agency)	• Leads day-to-day implementation of the ESMP Integrates ESMP measures into engineering contracts Monitors and reports on safeguard performance Engages with local authorities and communities
Supervising Consultant	• Monitor construction activities to ensure compliance with specifications and standards. • Prepare and submit progress reports to DAWASA. • Ensure proper documentation of all stages of construction. • Oversee implementation of the contractor's Health and Safety Plan.
Contractor(s)	• Implements all on-site mitigation measures • Ensures worker health, safety, and use of PPE • Maintains proper waste and storm-water management • Reports incidents and safeguard performance to DAWASA
Local Government Authorities (LGAs)	• Support community mobilization and grievance resolution Monitor social impacts and access disruptions Collaborate with DAWASA on resettlement (if any)
NEMC (Environmental Regulator)	• Provides technical oversight on environmental compliance • Conducts site inspections and reviews monitoring data Enforces environmental regulations as needed
Communities / Stakeholders	• Participate in consultations and grievance redress • Provide local monitoring feedback Engage in awareness programs on sanitation and health impacts

9.3.2 Coordination Mechanism

A project-specific Environmental and Social Safeguard Committee may be established at the DAWASA level to coordinate daily activities, reporting to MoW. Regular quarterly reviews will be held with participation from MoW, DAWASA, NEMC, contractors, and LGAs.

9.3.3 Capacity Building

Training will be provided to DAWASA, contractors, and LGA personnel on ESMP implementation, occupational health and safety, grievance redress mechanisms, and monitoring techniques.

9.3.4 Role and Responsibilities during ESMP Implementation

The Project Coordinator in the DAWASA office will be responsible for the overall monitoring and quality assurance of the Project. The project developer and the contractor shall be responsible for ESMP implementation; the Project coordinator will have a quality assurance and monitoring role including all safeguards aspects. The contractor will prepare and submit all safeguards progress and monitoring reports to the supervising Consultant who will later submit the reports to DAWASA. After internal scrutiny, DAWASA will submit the reports to Ministry of Water for further process.

9.4 ENVIRONMENTAL AND SOCIAL MANAGEMENT SPECIFICATIONS [ESMSs]

GENERAL

This specification specifies the requirements for the environmental management of the proposed projects, including general environmental controls, Environmental Management Plans and any sub-plans prepared specific for the project including approvals (i.e. materials extraction, water abstraction, vegetation clearances e.t.c) as well as site specific requirements such as soil erosion e.t.c.

RESPONSIBILITY

The Contractor is required to comply with the provisions of this specification and any other environmental protection provisions in the Contract and that the requirements of any applicable statute by-law, standard, and World Bank's ESS etc. related to environmental protection are observed. The environmental protection requirements in this Specification, together with the Conditions of Contract, are complementary to, and not in substitution for, any statutory requirements or any of the technical requirements of the Specifications and Drawings.

The accuracy of these legal obligations including all approvals/licences and all ancillary documentations is the responsibility of the contractor to check for relevance and currency. The Contractor shall comply with all relevant environmental statutory requirements and procedures defined within the Contractor's Environmental and Management Plan and all supplementary plans.

CHAPTER TEN

10.1 CONCEPTUAL DECOMMISSIONING PLAN

Introduction

A decommissioning plan outlines the procedures and responsibilities for safely removing infrastructure, restoring the project site, and mitigating any environmental or social impacts when the sewerage system reaches the end of its useful life or is replaced by another system. While the Sinza D Simplified Sewerage System is expected to operate for decades, planning for decommissioning ensures long-term sustainability and community safety.

11.2 Objectives of Decommissioning

- To dismantle infrastructure in a safe, environmentally sound, and socially responsible manner.
- To restore the site to a condition suitable for future land use or natural recovery.
- To minimize environmental and public health risks associated with residual waste or system failure.
- To comply with national environmental regulations and World Bank guidelines.

11.3 Scope of Decommissioning Activities

The decommissioning plan will apply to all physical components of the Sinza D simplified sewerage network, including:

- Sewer pipes and lateral connections.
- Inspection chambers and manholes.
- Any small-scale treatment or sedimentation units (if installed).
- Associated infrastructure (e.g., access covers, ventilation points).
- Temporary site facilities (if any are used during long-term operations).

11.4 Decommissioning Phases and Activities

Phase 1: Pre-Decommissioning Assessment

- Conduct a technical assessment to determine the remaining functional life of system components.
- Identify components that can be reused, recycled, or upgraded instead of dismantled.

- Consult with DAWASA, local government (Ubungo Municipal), and the community to determine future land use needs.
- Conduct an Environmental and Social Impact Review (mini-ESIA) specific to decommissioning.

Phase 2: Notification and Permitting

- Notify regulatory bodies including NEMC and Ubungo Municipal Council regarding the intent to decommission.
- Obtain decommissioning permits and any required clearances from environmental authorities.
- Prepare a Decommissioning Environmental and Social Management Plan (D-ESMP).

Phase 3: Physical Dismantling

- Safely cut and remove sewer pipelines, ensuring minimal ground disturbance.
- Excavate and remove inspection chambers and manholes.
- Drain and sanitize any tanks or underground vaults prior to dismantling.
- Transport reusable materials to DAWASA depots or approved recycling facilities.

Phase 4: Waste Management

- Segregate waste into categories: recyclable, hazardous (e.g., sludge residue), and general debris.
- Dispose of residual sludge and contaminated material at authorized treatment or landfill sites.
- Prevent leakage or runoff during removal by lining work zones and using sealed transport containers.

Phase 5: Site Restoration

- Backfill all excavated areas using clean, compacted soil and regrade surfaces to match surrounding terrain.
- Replant vegetation or restore surfaces to match prior land use (e.g., roads, pavements, gardens).
- Ensure safe drainage patterns are reinstated to avoid stagnant water or erosion.

11.5 Environmental Considerations

- **Air Quality**: Dust suppression will be conducted through water spraying. Equipment must meet emission standards.

- **Soil and Water**: Spill containment measures will be in place. Hazardous materials will not be stored on-site.
- **Noise**: Work will be limited to daytime hours. Machinery will be well-maintained to reduce noise.
- **Biodiversity**: Avoid decommissioning during breeding seasons for local wildlife, if present.

11.6 Social Considerations

- **Worker Safety**: Provide PPE, safety training, and emergency preparedness for all decommissioning staff.
- **Community Safety**: Fence off active zones and notify nearby residents of potential disruptions.
- **Livelihoods**: Provide temporary employment to local workers during dismantling and restoration phases.
- **Communication**: Maintain clear and ongoing community engagement, especially regarding traffic, access, and health precautions.

11.7 Institutional Roles and Responsibilities

Table 11-1 Institutional Roles and Responsibilities

Institution/Entity	Role and Responsibility
DAWASA	Lead implementing agency; overall responsibility for technical planning and supervision
Ubungo Municipal Council	Support local coordination and facilitate community involvement
NEMC	Regulatory oversight; review and approve D-ESMP and permits
Contractors	Execute dismantling and restoration works under DAWASA's supervision
Community Leaders	Support dissemination of information and resolution of grievances

CHAPTER ELEVEN

11.1 COST BENEFIT ANALYSIS

11.2 Project Budget

The investment cost for the proposed Faecal Sludge Treatment Plant is estimated to be around Tshs. 300 million that will be financed The World Bank.

11.3 JUSTIFICATION FOR RESOURCE EVALUATION

Regulation 18(1) of the Environmental Impact Assessment and Audit Regulations, 2005, requires that an Environmental Impact Statement should contain among others, a section discussion on the project's "resource evaluation or cost benefit analysis". The rule is that a Project should be undertaken if lifetime expected benefits exceeds all expected costs. The art of the analysis process comes in the measurement of these impacts, their adjustment for market failure, and for the effects of time, income distribution, incomplete information and potentially irreversible consequences. Although complexities arise when costs and benefits are being measured and corrected, CBA is a simple tool with numerous uses and applications, especially in the environmental assessment sphere. Its use increases accountability and consistency in decision-making.

The Cost-Benefit Analysis (CBA) provides a comprehensive assessment of the economic, environmental, and social trade-offs associated with the proposed Simplified Sewerage System in Sinza D, Ubungo Municipal, Dar es Salaam. It quantifies and qualifies the direct and indirect benefits of the project against the expected costs, including initial investment, operation and maintenance, and potential environmental liabilities. This helps determine the overall viability and justification of the project from a sustainability and development perspective.

CHAPTER TWELVE

12.1 CONCLUSION

The proposed project is of greater profit to the community and the country at large as it promotes and improve sanitation in the streets. When there is good and improved sanition, then the outbreak of diseases like diarhoea and associated stomach and waterborne diseases are also reduced and prevented hence improved public health.

The impacts identified are preventable and of less negativity to the community, therefore the developer can be provided with the environmental clearance certifacte in order to commence the implementation of the project.

It is, therefore, concluded that implementation of the proposed construction of the Simplified Sewarege System at Sinza D Mtaa will entail no detrimental impacts provided that the recommended mitigation measures are adequately and timely put in place. The identified adverse impacts shall be managed through the proposed mitigation measures and implementation regime laid down in this EIS. DAWASA is committed to implementing all the recommendations given in the EIS and further carrying out the environmental auditing and monitoring schedules.

By implementing the proposed measures, the project will minimize negative impacts such as soil erosion, water contamination, noise pollution, and disruption to local communities. Additionally, the ESMP promotes positive social outcomes, including improved sanitation, public health benefits, and job creation.

APPENDICES

Appendix i: Land Ownership Letter

HALMASHAURI YA MANISPAA YA UBUNGO

SIMU : 0222 926341
FAX: 0222 - 926342
Tovuti: www.ubungomc.go.tz
Barua Pepe:
ubo@ubungomc.go.tz

S.L.P. 55068,
DAR ES SALAAM

TAREHE: 28 MEI, 2021

AFISA MTENDAJI MKUU,
MAMLAKA YA MAJI SAFI NA USAFI WA MAZINGIRA,
S.L.P. 1573,
DAR ES SALAAM.

YAH: KUKABIDHIWA ENEO

Tafadhali husika na mada tajwa hapo juu na rejea kikao cha Kamati ya Mipango Miji na Mazingira cha tarehe **18 Mei, 2021** kilichojadili ombi lenu la matumizi ya eneo la **Kisopwa (Dampo)** pamoja na maeneo mawili ya Sinza 'D' na 'E' kwa ajili ya ujenzi wa miundombinu ya maji taka.

Napenda kuwajulisha kuwa, kikao kimeridhia kukabidhiwa maeneo hayo kwa matumizi ya miundombinu ya maji taka kama ifuatavyo:-

1. Eneo la Kisopwa mita za mraba 50,000
2. Eneo la Sinza 'D' mita za mraba 1,757
3. Eneo la Sinza 'E' mita za mraba 1,645

Maeneo yote yatabakia kuwa chini ya umiliki wa Halmashauri wa Manispaa ya Ubungo. Wajibu Mamlaka ya Maji safi na Maji taka kupewa kusaini Hati ya Makubaliano na Halmashauri ya Manispaa ya Ubungo kuhusu uendelezaji wa maeneo tajwa.

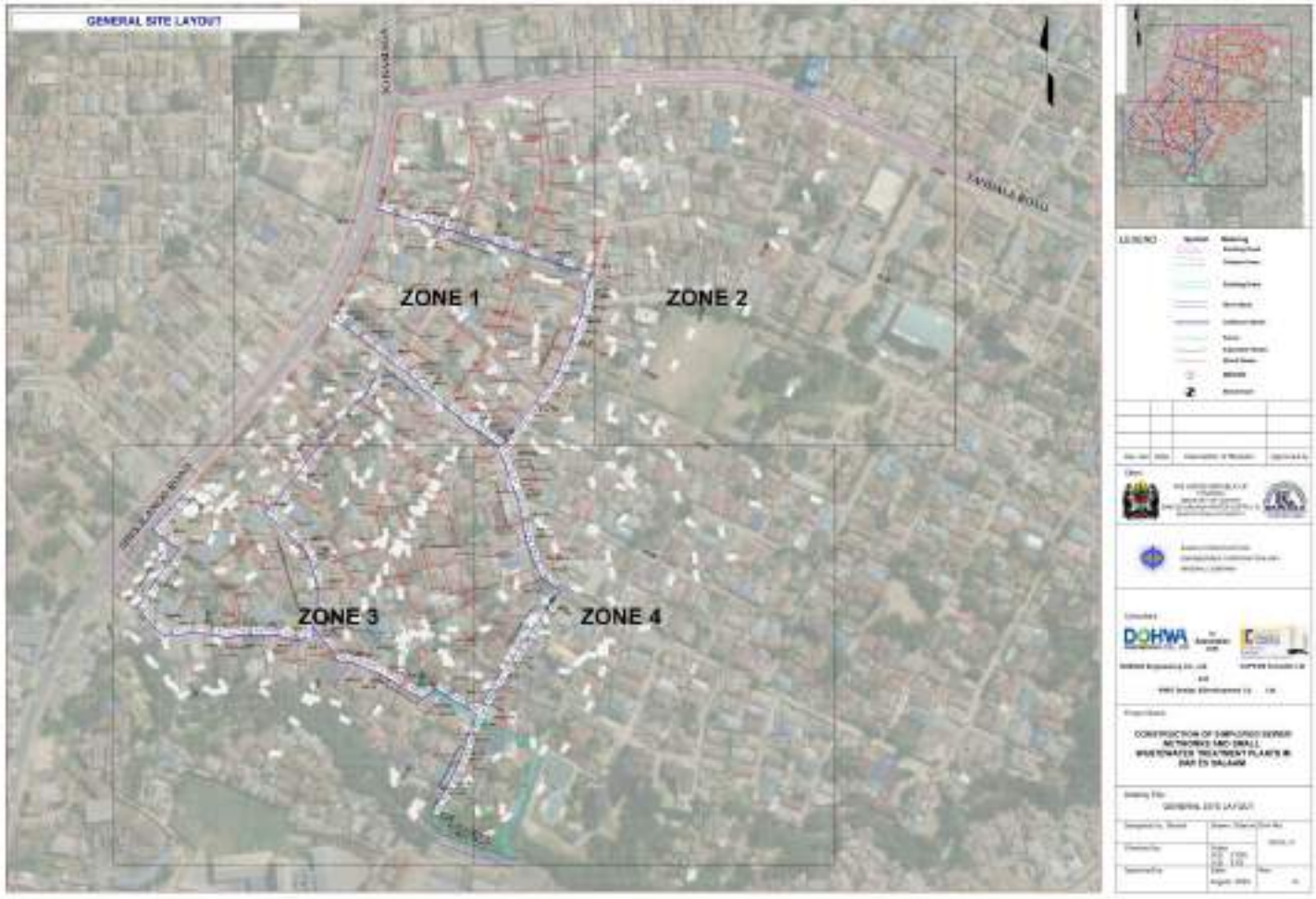
Nakutakia kazi njema.

Beatrice R. Dominic
MKURUGENZI WA MANISPAA
HALMASHAURI YA MANISPAA YA UBUNGO

Nakala:
1) Katibu Tawala wa Mkoa,
Mkoa wa Dar es Salaam,
Barabara ya Rashid Kawawa
S.L.P. 5429,
DAR ES SALAAM.

2) Katibu Tawala wa Wilaya,
Wilaya ya Ubungo,
S.L.P. 55468,
DAR ES SALAAM

Appendix ii: Site Layout plan



Appendix iii: Stakeholders Consultaion & Meeting Minutes

ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA) STUDY:

MAONI YA WADAU KWA AJILI YA UANZISHWAJI WA MRADI WA MFUMO RAHISI WA UKIUSANYAJI NA UCHAKATAJI WA MAJI TAKA UTAKAOJENGWA KATIKA MTAA WA SINZA D, KATA YA SINZA, MANISPAA YA UBUNGO KATIKA MKOA WA DAR ES SALAAM

S/N	DATE/ TAREHE	NAME/ JINA	INSTITUTION/ TAASISI	POSITION/ CHEO	PHONE NO./ SIMU	SIGNATURE/ SAHIHI
	24/10/2025	[illegible]	[illegible]	[illegible]	[illegible]	
	24/10/2025	JESCA STANLEY	UBUNGO M.C	[illegible]	[illegible]	
	24/10/2025	ENG. DENIS CHALA MBA	TARURA UBUNGO	HE	0713607236	

MUHUTASARI WA MKUTANO WA WANANCHI WA ENEO LA MRADI WA MAJI TAKA ULIOFANYIKA TAREHE 23/5/2025

AGENDA ZA MKUTANO

1. KUFUNGUA MKUTANO
2. UTAMBULISHO
3. TAARIFA YA MWENDELEZO WA MRADI WA MAJI TAKA
4. KUFUNGUA MKUTANO

1. KUFUNGUA MKUTANO

Awali ya yote mwenyekiti alifungua mkutano kwa kuwakaribisha wageni kutoka DAWASA pamoja na wananchi waliohudhuria mkutano huo. Mkutano ulifunguliwa majira ya saa nne asubuhi.

2. UTAMBULISHO

Baada ya mwenyekiti kufungua mkutano aliwakaribisha wageni kutoka DAWASA ili wajitambulishe kwa wananchi. Kila kiongozi alijitambulisha kwa cheo chake pia utambulisho uliendelea kwa viongozi wa serikali ya mtaa na wanachi waliohudhuria mkutano huo.

3. TAARIFA YA MWENDELEZO WA MRADI WA MAJI TAKA SINZA 'D'

Katibu wa mtaa aliwakaribisha viongozi kutoka DAWASA kwa kutoa ufafanuzi wa mwendelezo huu wa mradi, mradi unahusisha ujenzi wa mfumo rahisi wa kuondosha majitaka pamoja na mtambo wakuchakata majitaka. kiongozi mmoja wa mmoja wa DAWASA alianza kwa kusema, kuwa ndugu wananchi mradi huu sio ngeni ni mwendelezo wa mradi kwa pale tulipoishia na sasa tupo katika hatua ya mwendelezo wa mradi, alisema kuwa mradi huu unagharimu kiasi cha Tsh 9,022,243,047.85 kwa urefu wa kilomita 5.8, aliendelea kwa kusema mradi huu utakua na mtambo wenye uwezo wa kuchakata mita za ujazo 149.4m3 kwa siku. Hivyo ujenzi umeishaanza na unaendelea.

Alisema nyumba 318 zitaunganishwa.

Baada ya maelezo hayo mwenyekiti alisema ndugu wananchi kama walivyosema DAWASA mradi sasa unaendelea, mshauri wa mradi aliongeza kwa kusema tutashirikishana kwa kila hatua. Aliendelea kwa kusema mradi huu utasaidia

kuondokana na tatizo la kufaurishwa majitaka, alisema pia uchimbaji umeshaanza tunaomba tuendelee kushirikiana bega kwa bega.

Kiongozi wa DAWASA alisema changamoto hazikosekani hiyo ni halia ya kawaida ila mradi unaendelea. Baada yah apo mwenyekiti aliwakaribisha wananchi kama wanachochote cha kuuliza.

Mama akida alisema anatoka shina namba 1 alisema anashukuru sana kwa mradi japo kuna baadhi ya watu walikua wanapinga ila binafsi napenda mradi uendelee.

Mjumbe kiponza alisema kuwa napongeza mradi kurudi ila swali langu, ikitokea mipango miji kupitisha miundo mbinu ya barabara, mabomba ya maji safi mambo hayo yatakizi vigezo? Na je yule mama anaelalamika ameridhia? Mwezeshajia alisema kuwa hilo swala la swaumu lipo chini ya serikalia ya mtaa n ahata hvyo swala lake lipo sehemu sashihi na hata leo tulitamani awepo tunafanya kazi kwa kushrirkiana na jamii.

Baada ya maelezo hayo mwenyekiti aliwauliza wananchi kama kuna mtu anasawali au dukuduku lolote

Wananchi kwa pamoja walisema kuwa mradi wanautaka na wanaona kama wanachelewa kutokana na hali ya kimazingira ya mtaa wa sinza.

4. **KUFUNGA MKUTANO**

Mwenyekiti aliwashukuru sana wawezeshaji pamoja na wananchi kwa kuukubali mradi uendelee

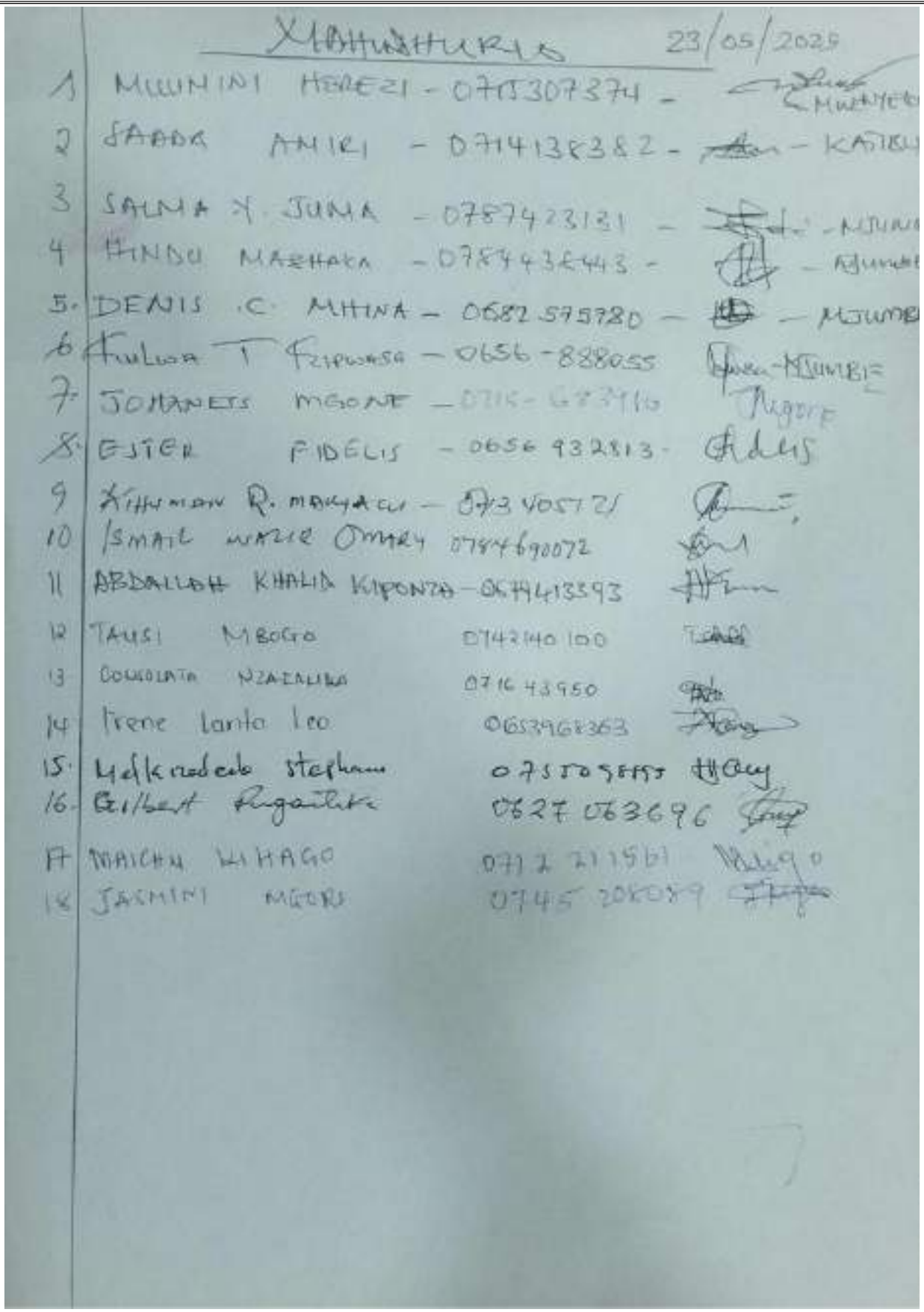
Kikao kilihairishwa na mwenyekiti majira ya saa sita na nusu mchana [6:30]

Mwenyekiti wa mtaa

.....

Mtendaji wa mtaa siza 'D'

.....



Appendix iv: Screening Letter

THE UNITED REPUBLIC OF TANZANIA

VICE PRESIDENT'S OFFICE

NATIONAL ENVIRONMENT MANAGEMENT COUNCIL (NEMC)

In reply please quote:
Ref: **HA. 145/208/64/02**

Date: 08/07/2025

Dar es Salaam Water supply & Sanitation Authority
P. O. Box 1573,
Dar es Salaam.

RE: THE SCREENING DECISION FOR THE PROPOSED CONSTRUCTION OF SIMPLIFIED SEWERAGE SYSTEM TO BE CONSTRUCTED AT SINZA D, SINZA WARD, UBUNGO MUNICIPALITY

Reference is made to the above heading.

2. We acknowledge receipt of your Registration Form and Project Brief report for undertaking an Environmental Impact Assessment (EIA) for the above-stated project.

3. Having reviewed the submitted documents, the Council reached a decision that your project does not require a full EIA study. You are therefore required to submit detailed Project Brief report, which will guide the Council in decision making.

4. The Project Brief report should conform to the EIA and Audit (Amendment) Regulations, 2018 particularly Regulation 6(1) for contents. Among others, the detailed Project Brief should include the following:

i. The site location, accessibility and the physical area that may be affected by the project activities;
ii. The activities with explanations that shall be undertaken during mobilisation, construction, operation and decommissioning;
iii. Information on all types of waste that will be generated by the project in all project phases and its management;
iv. All components must be explained in detail and their designs attached;
v. Baseline data on air quality, water quality and hydrology at the project site;
vi. Details on storm water management;
vii. The potential environmental, economic and socio-cultural impacts of the and the mitigation measures to be taken during and after implementation of the project;
viii. All issues pertaining to Occupational Health & Safety of workers during all phases of project are discussed;
ix. Detailed stakeholders' consultations including but not limited to, OSHA, Municipal Council, Ward Offices, Mtaa offices and **Neighbours**. Their views

Eastern Zone North, 35 Regent Street, P.O.Box 63154, 11404 Dar es salaam, Phone +255 22 2774852; +255 22 2774568; +255 713 608930/0735808930 Fax: +255 22 2774901
Email Address: dg@nemc.or.tz Website: www.nemc.or.tz

and concerns should be responded by the developer and included in the report. Minutes of the meetings, names and signatures of all the consulted stakeholders should be appended to the Project Brief;

x. Detailed Environmental Management and Monitoring Plans; and

xi. The report should have the following attachments:

a) Certificate of Taxpayer Identification Number
b) Detailed engineering designs and architectural drawings;
c) Clear site layout plan of the project indicating all project components;
d) Building and Operating permits and other relevant permits and regarding the project; and
e) The documents that confirm the project investment cost, from registered Quantity Surveyor.

5. As you submit the detailed Project Brief report, you will be required to as well pay to the Council a review cost as indicated in the Invoice which has been generated by the system.

6. Contact us in case you need any further information or clarifications on this matter through Telephone No. +255 710285832

Glory Kombe
For: DIRECTOR GENERAL

Eastern Zone North, 35 Regent Street, P.O.Box 63154, 11404 Dar es salaam, Phone +255 22 2774852; +255 22 2774889; +255 713 606930/0735606930 Fax: +255 22 2774901
Email Address: dg@nemc.or.tz Website: www.nemc.or.tz

Stakeholders meeting at Sinza D

APPENDIX IV: Non-Technical Summary

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF WATER

Dar es Salaam Water supply & Sanitation Authority

DAWASA Building, Dunga/Malaga Street,
Mwananyamala Area
P. O. Box 1573, Dar es Salaam. TANZANIA.
Tel. +25522276006/15; Fax: +255222762480;
E-mail: dawasaceo@dawasa.co.tz

Tathmini ya Athari kwa Mazingira na Jamii kwa Mradi pendekezwa wa Ujenzi wa Mfumo rahisi wa ukusanyaji wa maji taka katika Mtaa wa Sinza D, kata ya Sinza, Halmsahauri ya Manispaa ya Ubungo, Mkoa wa Dar es Salaam

Lead Consultant:

Prof. Rubhera RAM Mato (PhD), CEng. (T), Reg. EIA Expert
Mobile: +255754898592; E-Mail: rubheramato@gmail.com

Submitted to:

National Environment Management Council
Regent Estate, Mikocheni**, P. O. Box 63154,Dar es Salaam.**
Tel: +255 22 2774852/ 0713608930;Fax: +255 22 2774901E-mail: gd@nemc.or.tz

Submitted: February, 2026

MUHTASARI USIO WA KIUFUNDI

Tathmini ya Athari kwa Mazingira na Jamii kwa Mradi pendekezwa wa Ujenzi wa Mfumo rahisi wa ukusanyaji wa maji taka katika Mtaa wa Sinza D, kata ya Sinza, Halmsahauri ya Manispaa ya Ubungo, Mkoa wa Dar es Salaam

Mmiliki: Dar es Salaam Water Supply & Sanitation Authority

Mawasliano ya Mmiliki: DAWASA,
DAWASA Building, Dunga/Malaga Street, Mwananyamala
S.L.P 1573, Dar es Salaam. TANZANIA.
Simu. +25522276006/15; Fax: +255222762480;
Barua Pepe: dawasaceo@dawasa.co.tz

Mshauri Mwelekezi: Prof. Rubhera RAM Mato (PhD), CEng. (T), Reg. EIA Expert
S.L.P 35478, Dar es Salaam, Tanzania
Simu: +255754898592
Barua Pepe: rubheramato@gmail.com

UTANGULIZI

SERIKALI ya Jamhuri ya Muungano wa Tanzania kupitia Mamlaka ya Majisafi na Majitaka Dar es Salaam (DAWASA) chini ya Wizara ya Maji inatarajia kutekeleza Mradi wa Usafi wa Mazingira nje ya mfumo rasmi katika Jiji la Dar es Salaam ili kuhudumia maeneo ya pembezoni mwa miji hususan maeneo ambayo hayajaunganishwa na mfumo mkuu wa maji taka. DAWASA imepata ufadhili kutoka kwa Jumuiya ya Maendeleo ya Kimataifa ikiwa ni mkopo wa kutekeleza mradi huo. Kabla ya kutekeleza mradi huo, sheria nchini Tanzania inataka Tathmini ya Athari kwa Mazingira ifanyike na kuidhinishwa na mamlaka husika. Ili kuzingatia sheria nchini Tanzania, DAWASA inatarajia kutumia sehemu ya mapato ya mikopo kwa malipo stahiki kwa ajili ya huduma za ushauri kwa ajili ya Maandalizi ya Tathmini ya Athari kwa Mazingira na Kijamii na andiko la Mpango Kazi wa Makazi mapya na fidia kwa ajili ya ujenzi wa mradi wa usafi wa mazingira nje ya mfumo rasmi.

Mradi wa usafi kwa maeneo yaliyo nje ya mfumo rasmi umegawanywa katika miradi midogo kadhaa ambayo itatekelezwa katika manispaa tano za Jiji la Dar es Salaam. Mojawapo ni Ujenzi wa Mfumo wa Rahisi wa ukusanyaji wa majitaka katika Mtaa wa Sinza D, katika Kata ya Sinza, Manispaa ya Ubungo. Mradi umepangwa kuunganisha kaya 300.

Uandaaji wa andiko hili ulifanyika kwa kufuata Kanuni za Usimamizi wa Mazingira (Tathmini na Ukaguzi wa Athari kwa Mazingira) (Marekebisho), 2018 pamoja na Tathmini ya Athari kwa Mazingira na Kanuni za Ukaguzi za mwaka 2005. Kanuni hizi

zinatoa taratibu za kisheria za kutekeleza matakwa ya Sheria ya Usimamizi wa Mazingira Sura ya 191. ya 2004. Kanuni zinatoa mamlaka kwa *Baraza la Taifa la Hifadhi na Usimamizi wa Mazingira* kusimamia mchakato wa, kutoa Cheti cha cha Mazingira.

Kufuatia Kanuni za za Usimamizi wa Mazingira *Baraza la Taifa la Hifadhi na Usimamizi wa Mazingira* ina jukumu la kuchunguza miradi na kufanya maamuzi ya kiwango cha Tahtmini kinachohitajika pamoja na kutathmini utoshelevu wa taarifa za mazingira husika. Kwa kuzingatia aina na ukubwa wa mradi pendekezwa wa “Mfumo wa Rahisi wa Maji taka katika Halmsahauri ya Jiji la Dar Es Salaam”, mradi upo chini ya Kitengo “B2” (ambapo miradi iliyopo kwenye kundi hili haihitaji tatahmini ya kina). Hivyo miradi haitahitaji tahmini na uchunguzi wa kina, badala yake, Muhtasari au andiko lenye taarifa zote za muhimu kuhusu mradi itahitajika na kuwaslishwa kwa Baraza ili ifanyiwe uhakiki na kisha Cheti cha Tathmini ya Athari kwa Mazingira kitolewe na Baraza'. Kanuni zinawataka washauri walelekezi kutayarisha na kuwasilisha kwa *Baraza la Taifa la Hifadhi na Usimamizi wa Mazingira* Muhtasari wa Miradi” kwa miradi yote ya B2. Maandalizi na maudhui ya “Muhtasari wa Mradi” yametolewa chini ya Reg.6 (1). Vile vile vimefuatwa katika kuandaa "Muhtasari wa Mradi". Kazi ya kuandaa muhtasari wa mradi huu ilifanyika Aprili hadi Agosti Mwaka 2026.

MAELEZO YA MRADI

Mradi upo katika Sinza D, Manispaa ya Ubungo, Jiji la Dar es Salaam. Eneo lina msongamano mkubwa wa watu, kiwango kidogo cha huduma za usafi wa mazingira, na liko karibu na makazi ya watu pamoja na miili ya maji asilia. Ramani zinazoonesha eneo la mradi, kaya jirani na mito/mitiririko ya maji zimeandaliwa na zimeambatanishwa katika ripoti kuu.

SERA, SHERIA NA KANUNI

Sera za kisekta ambazo zilipitiwa upya wakati wa kutekeleza andiko la mradi huu pendekezwa ni:-

- Sera ya Taifa ya Mazingira ya 1997
- Sera ya Taifa ya Ardhi ya mwaka 1997
- Sera ya Sekta ya Ujenzi (2003)
- Sera ya Taifa ya Afya (2003)
- Sera ya Taifa ya Jinsia ya 2000
- Sera ya Taifa ya Maendeleo ya Makazi (2000)

Sheria Kuu, kanuni na miongozo inayosaidia kutekeleza mradi uliokusudiwa ni

- Sheria ya Usimamizi wa Mazingira (2004)
- Kanuni za Usimamizi wa Mazingira (Ada na Ada) za 2021
- Kanuni za Usimamizi wa Mazingira (Udhibiti wa Taka hatarishi), 2021
- Kanuni za Usimamizi wa Mazingira (Udhibiti wa Kelele na Mtetemo), 2015
- Kanuni za Usimamizi wa Mazingira (Marufuku ya Mifuko ya Plastiki), za 2019
- Kanuni za Usimamizi wa Mazingira (Udhibiti wa Taka Ngumu), 2007
- Kanuni za Usimamizi wa Mazingira (Ubora wa Maji), 2009
- Kanuni za Usimamizi wa Mazingira (Ubora wa Hewa), 2009
- Kanuni za Usimamizi wa Mazingira (Ubora wa Udongo), 2009
- Sheria ya Afya na Usalama Kazini ya 2003
- Sheria ya Ugavi wa Maji na Usafi wa Mazingira Na. 12 ya 2009
- Sheria ya Usajili wa Wahandisi na Marekebisho yake ya 1997 na 2007
- Sheria ya Usajili wa Makandarasi (Marekebisho) ya mwaka 2008
- Miongozo ya Benki ya Dunia ya Urb kwa Sheria ya Mipango ya Usimamizi wa Mazingira (2007)
- Sheria ya Afya ya Umma (2009)

USHIRIKISHWAJI WA WADAU

Wadau walioshirikishwa ni pamoja na:

- Serikali za mitaa
- Viongozi wa jamii na wakazi
- Wanawake na makundi maalum
- Watumishi wa DAWASA

Masuala makuu yaliyoibuliwa yalihusu harufu, matumizi ya ardhi, fidia, athari za kiafya na usawa wa upatikanaji wa huduma. Maoni ya wadau yalitumiwa kuboresha usanifu wa mradi na hatua za udhibiti wa athari.

Miongoni mwa masuala yanayojitokeza wakati wa mashauriano na wadau ni pamoja na:

- Jamii ijengewe uwezo juu ya uendeshaji wa mfumo, kwa kuwa ni teknolojia mpya
- Uhamasishaji kwa jamii kuepuka machafuko siku za usoni
- Gharama za uendeshaji ziwe rafiki kwa wanufaika wa huduma hii

MAHITAJI YA MRADI NA UZALISHAJI WA TAKA

Mahitaji ya mradi

Nyenzo kuu za ujenzi wa mfumo rahisi wa maji taka ni pamoja na saruji, (mawe), maji, mchanga, mbao, mabomba ya PVC na changarawe. Wakati wa awamu ya ujenzi mradi utahitaji wafanyakazi wasiopungua 100 wenye ujuzi na vibarua wasio na ujuzi kwa kila awamu ya ujenzi wa mradi. Wakati wa awamu ya uendeshaji inakadiriwa kuwa wafanyakazi 30 wasio na ujuzi watahifadhiwa kwa uendeshaji wa mfumo.

Uzalishaji wa taka

Taka ngumu na taka laini zinategemewa kuwa zitazalishwa wakati wa kipindi chote cha ujenzi na utkelezwaji wa mradi huu. Mkandarasi atahakikisha kuwa na mfumo na udhibiti mzuri wa taka hizi ili kuepusha uchafuzi wa mazingira.

ATHARI ZINAZODHANIWA KUTOKEA

Hatari za Kimazingira na Kijamii

Hatari zilizobainishwa ni pamoja na:

- Kuingia kwa maji ya mvua kwenye mfumo wa majitaka
- Uzalishaji wa harufu mbaya na uchafuzi wa hewa
- Uchafuzi wa maji kutokana na uvujaji au kufurika kwa majitaka
- Migogoro ya matumizi ya ardhi na uwezekano wa kuhamishwa kwa jamii
- Hatari za afya na usalama wakati wa kutoa tope (desludging)
- Migogoro ya kijamii endapo ushirikishwaji wa wadau hautazingatiwa

Orodha ya kina ya hatari (Risk Register) imeandaliwa na kujumuishwa katika ESMP.

Hatua za Kuzuia na Kupunguza Athari

Hatua za kiuhandisi na kiusimamizi zimejumuishwa ili kudhibiti athari, zikiwemo:

- Matumizi ya mashimo ya ukaguzi yaliyofungwa na mifumo ya kutoa hewa kwa kudhibiti harufu
- Uwekaji wa mifumo bora ya mifereji ya maji ya mvua
- Matumizi ya maeneo yaliyoidhinishwa kwa utupaji wa tope la majitaka
- Ushirikishwaji wa wadau na mfumo wa kushughulikia malalamiko (GRM)

- Uzio wa maeneo ya kazi, alama za tahadhari na udhibiti wa usalama wa wananchi

Mpango wa Usimamizi wa Mazingira na Jamii (ESMP)

Mpango huu wa udhibiti wa mazingira unaelezea athari ambazo zitatokana na utekelezwaji wa mradi pamoja na njia za kudhibiti athari hizo, pamoja na hayo pia mpango huu unaonyesha mhusika ambaye atasimamia mpango huu na kuhakikisha kuwa unafanya kazi vizuri pamoja na gharama za udhibiti kwa kila athari iliyoainishwa. Mpango huu umehusisha hatua zote za mradi kuanzia ujenzi, uendeshaji pamoja na kumaliza mradi.

Mpango wa usimamizi umeainisha:

- Athari za kimazingira na kijamii
- Hatua za kudhibiti athari
- Wadau wanaowajibika kutekeleza hatua hizo
- Gharama zinazokadiriwa kufikia **TZS 50,000,000/=**

Athari na hatua za udhibiti zimepangwa kulingana na awamu za mradi (Ujenzi, Uendeshaji na Kufunga Mradi) pamoja na aina ya athari (kimazingira au kijamii).

Mpango wa Ufuatiliaji

Mpango wa ufuatiliaji unahusisha:

- Vigezo muhimu kama PM10, H_2S, kelele, chumvi (salinity) na TDS
- Muda wa ufuatiliaji (kila siku, kila mwezi na kila robo mwaka)
- Wadau wanaohusika (DAWASA, Wakandarasi na Wizara ya Maji)
- Viwango vya kufuata sheria na taratibu za utoaji wa taarifa

HITIMISHO

Mradi huu pendekezwa wa mfumo rahisi wa ukusanyaji wa majitaka unafaida kubwa sna kwa jamii na kwa mzaingira, kwani Jiji la Dar es Salaam lina changamoto kubwa sana ya mfumo wa maji taka, hivyo mradi huu utaondoa changamoto hii na kupunguza utiririshwaji wa majitaka kutoka vyooni. Mradi huu ni rafiki kwa mazingira kwani athari hasi ambazo nimeainishwa ni za kawaida na zinazuilika, mbali na hiyo mradi una athari chanya zenye manufaa kwa taifa.

THE UNITED REPUBLIC OF TANZANIA

MINISTRY OF WATER

Dar es Salaam Water supply & Sanitation Authority

DAWASA Building, Dunga/Malaga Street,
Mwananyamala Area
P. O. Box 1573, Dar es Salaam. TANZANIA.
Tel. +25522276006/15; Fax: +255222762480;
E-mail: dawasaceo@dawasa.co.tz

NON-TECHNICAL SUMMARY

DETAILED PROJECT BRIEF FOR THE PROPOSED CONSTRUCTION OF SIMPLIFIED SEWERAGE SYSTEM TO BE CONSTRUCTED AT SINZA D, SINZA WARD, UBUNGO MUNICIPALITY IN DAR ES SALAAM REGION

Lead Consultant:
Prof. Rubhera RAM Mato (PhD), CEng. (T), Reg. EIA Expert
Mobile: +255754898592; E-Mail: rubheramato@gmail.com

Submitted: February, 2026

EXECUTIVE SUMMARY

Proponent: DAWASA

Proponent's Contact: DAWASA House, **Dunga/Malanga**

Street/Mwananyamala

P.O Box 1573 DSM

Tel: +255222760006/15

Fax: +255222762480

Email Address: info@dawasa.go.tz

EIA Expert: **Prof. Rubhera RAM Mato**

(PhD), CEng. (T), Reg. EIA Expert

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Project Overview

The proposed Sinza D Simplified Sewerage System Project is a key intervention under the Off-Grid Sanitation Project being implemented by DAWASA (Dar es Salaam Water and Sanitation Authority) under the oversight of the Ministry of Water (MoW), with financial support from the World Bank. The project aims to improve access to safe and affordable sanitation services in the high-density Sinza D area in Dar es Salaam by constructing a simplified sewerage network and decentralized treatment system.

Need for the Project

The project responds to the acute sanitation challenges in urban informal settlements where conventional sewerage systems are not feasible. Currently, most households in Sinza D rely on poorly maintained on-site sanitation facilities, leading to public health concerns and environmental degradation. The intervention will support SDG 6 (Clean Water and Sanitation) by improving wastewater management, enhancing environmental quality, and promoting public health.

Project Components

- Pipeline network (total length: approximately 6 km) – Smaller diameter sewer pipes (100mm) that collect wastewater from households and communal facilities.
- Manholes and inspection chambers - Maintenance and monitoring points for operations, preventing blockages.
- Household connections (estimated 300 households) - Linking household waste discharge points (toilets, greywater drains) to the main line. Where

households currently use pit latrines or septic tanks, conversion works will be done to allow safe flow into the sewer.

- Wastewater treatment Plant - Sustainability and standard compliance of final effluent before discharge.

Project Location

The project is located in Sinza D, Ubungo Municipality, Dar es Salaam. It is characterized by high population density, poor sanitation coverage, and proximity to residential structures and natural water bodies. Maps showing the project area, nearby households, and the adjacent river/stream have been prepared and are included in the main report.

Site Selection and Alternatives

The site was selected based on:

- High population density with low sanitation coverage and high disease incidence.
- Site Locations with respect to business land use, & buildings
- Soil type if allows shallow sewers
- Topography of the areas to allow gravity flow
- Access roads and paths to allow gravity routes of pipeline flows
- Availability of discharge/disposal of the wastewater
- Locally available of construction material

Alternative options including offsite sewer networks and conventional systems were assessed but deemed cost-prohibitive or technically unviable in the dense urban fabric of Sinza D.

Legal and Institutional Framework

The ESMP is guided by:

- National Environmental Policy (1997)
- Water Supply and Sanitation Act (2019)
- MoW's National Guidelines for Wastewater Management (2019)
- TBS Wastewater Discharge Standards (TZS 860:2006)
- World Bank Environmental and Social Framework (ESF)

Environmental and Social Risks

Risks identified include:

- Storm-water infiltration
- Odor emission and air quality degradation
- Water contamination from leaks or overflow
- Community displacement and land-use conflicts
- Health and safety risks during desludging
- Social unrest due to poor stakeholder engagement

A detailed Risk Register is included in the ESMP to manage these risks proactively.

Mitigation Measures

The project design incorporates several engineering and management strategies to mitigate risks:

- Sealed manholes and venting for odor control
- Proper drainage to manage stormwater
- Use of licensed sludge disposal sites
- Stakeholder engagement and GRM mechanisms
- Site fencing, signage, and access safety measures

Environmental and Social Management Plan (ESMP)

An ESMP table outlines:

- Environmental and social impacts
- Mitigation measures
- Responsible parties

- Estimated costs in Tanzanian Shillings 50,000,000/=

Impacts and mitigations are categorized by phase (Construction, Operation, and Decommissioning) and type (Environmental or Social).

Monitoring Plan

The monitoring framework includes:

- Key parameters (PM10, H_2S, noise, salinity, TDS)
- Frequency of monitoring (daily, monthly, quarterly)
- Assigned responsibilities (DAWASA, Contractors, MoW)
- Thresholds for compliance and reporting obligations

Stakeholder Engagement

Stakeholders engaged include:

- ✓ Local government authorities
- ✓ Community leaders and residents
- ✓ Women and vulnerable groups
- ✓ DAWASA field staff and operators

Key concerns raised included odor, land use, compensation, health impacts, and equitable access. Feedback was used to shape the design and mitigation plan.

Roles and Responsibilities

- ✓ Ministry of Water (MoW): Policy oversight, technical support, regulatory enforcement
- ✓ DAWASA: Project implementation, O&M, community engagement, reporting
- ✓ Contractors: Compliance with ESMP, safe construction practices
- ✓ NEMC & Local Authorities: Monitoring, enforcement, and grievance resolution

Conclusion

The Sinza D Simplified Sewerage System is a vital infrastructure project that addresses critical public health and environmental needs in urban Dar es Salaam. By following the ESMP, the project will manage environmental and social risks while promoting inclusive, sustainable sanitation development. The collaboration between DAWASA, the Ministry of Water, the World Bank, and local stakeholders will ensure responsible implementation and long-term benefits for the community.

Appendix v: Grievance Resolution Letter from Ubungo Municipal

JAMHURI YA MUUNGANO WA TANZANIA

OFISI YA RAIS

TAWALA ZA MIKOA NA SERIKALI ZA MITAA

WILAYA YA UBUNGO
Anuani ya Simu

Simu Na. 022 – 2926340/5

OFISI YA MKUU WA WILAYA,
2 Barabara ya Morogoro,
S.L.P. 55064,
UBUNGO,
14882 DAR ES SALAAM.

Kumb.Na: AB.45/50/01/07

30 Septemba, 2025

Katibu Mkuu,
Wizara ya Maji,
S.L.P. 456,
DODOMA.

Yah: TAARIFA YA MALALAMIKO YA BI. SAUMU S. MJUNGU KWA AJILI YA UTEKELEZAJI WA MRADI WA MFUMO RAHISI WA UONDOSHAJI MAJI TAKA MAJUMBANI MTAA WA SINZA "D" KATA YA SINZA

Kichwa cha habari hapo juu chahusika.

2. Nakutumia malalamiko ya mtajwa hapo juu kwa ajili utekelezaji wa mradi wa Mfumo Rahisi wa Uondoshaji Maji Taka Majumbani Mtaa wa Sinza "D" Kata ya Sinza.

3. Ninakushukuru kwa ushirikiano wako.

Hassan M. Mkwawa
KATIBU TAWALA WILAYA
UBUNGO

Nakala: Mkuu wa Wilaya,
UBUNGO. - Alone kwenye jalada

TAARIFA YA MALALAMIKO YA BI. SAUMU S. MJUNGU KWA AJILI YA UTEKELEZAJI WA MRADI WA MFUMO RAHISI WA UONDOSHAJI MAJI TAKA MAJUMBANI MTAA WA SINZA "D" KATA YA SINZA

1.0 Historia:

Katika kutekeleza mradi wa Uondoshaji wa maji taka unaotekelezwa na mfumo wa DAWASA Mtaa wa Sinza "D" Kata ya Sinza kumekuwa na malalamiko kutoka kwa Bi. Saumu S. Mjungu. Malalamiko yake yalijikita katika maeneo mawili:-

(1) Kushuka thamani kwa eneo kwa kuitwa eneo la Dampo la Maji Taka na harufu mbaya katika eneo hilo. Malalamiko hayo yaliwasilishwa ngazi ya Mtaa na kutolewa majibu na Afisa Mtendaji wa Mtaa kupitia dawati la malalamiko, baada ya majibu ya tarehe 12/02/2025 akasaini fomu za malalamiko za kutoridhika na ufafanuzi aliopewa ngazi ya Mtaa. Mlalamikaji aliendelea ngazi ya Kata tarehe 06/03/2025 kuwasilisha malalamiko yake ngazi ya Kata ambapo pia alijibiwa na kupata ufafanuzi wa malalamiko hayo kupitia Dawati la malalamiko ngazi ya Kata ya Sinza tarehe 06/03/2025 lakini bado hakuridhika na ufafanuzi.

Kutokana na hali hiyo Mhe. Mkuu wa Wilaya Ubungo aliunda Kamati ya Wataalam ili kulitolea majibu malalamiko tajwa na katika majibu ya kitaalam ya Kamati hiyo yalifafanuliwa kitaalam kuhusu malalamiko yake ikiwemo afya, ardhi na fidia na thamani ya ardhi kama ifuatavyo:-

1.1 Athari za Afya:

Kutokana na taarifa ya athari za afya na mazingira iliyotolewa na Baraza la Mazingira (NEMC) ilionesha kuwa hakuna madhara yoyote ya kiafya yanayoweza kujitokeza kwa ajili ya mradi huo.

1.2 Umiliki wa ardhi:

Kwa mujibu wa mchoro wa Mipango Miji namba 1/73/174 Sinza Layout, eneo hili ilitengwa kama hifadhi ya Mto Ng'ombe. Aidha kwa mujibu wa Sheria ya Mipango Miji Na. 8 ya mwaka 2007, maeneo ya hifadhi ya Mto yapo chini ya usimamizi wa Mamlaka ya Upangaji na hayapaswi kuendelezwa kwa ujenzi wa kudumu. Mlalamikaji sio mmiliki wa eneo ambapo mradi unajengwa.

1.3 Mradi kushusha thamani ya eneo:

Utekelezaji wa mradi hautashusha thamani ya eneo kwa sababu.

1.3.1: Mradi hauna athari zozote za kiafya

1.3.2: Mradi hauta sababisha uchafuzi wa mazingira ikiwemo kutoa harufu mbaya

1.3.3: Badala yake mradi utatengeneza thamani ya maeneo ya Kata ya Sinza kutokana na kuwepo miundo mbinu ya uondoshaji maji taka.

1.4 Fidia

Mlalamikaji hasitahili kulipwa fidia kwa kuwa sio mmiliki halali wa eneo.

2.0 Hatua za utatuzi

2.1 Mlalamikaji alipatiwa ufafanuzi na dawati la malalamiko ngazi ya Mtaa wa Sinza "D" tarehe 12/02/2025.

2.2 Mlalamikaji alipatiwa ufafanuzi na dawati la malalamiko ngazi ya Kata ya Sinza tarehe 06/03/2025.

2.2.1 Pamoja na ufanunuzi mbalimbali ambao ameendelea kupata mlalamikaji alipelekwa eneo la Mtaa wa Mji Mpya Kata ya Kipawa tarehe 08/03/2025 ambapo mradi kama huo unatekelezwa katika eneo hilo, japokuwa kipindi anapelekwa mradi ulikuwa haujaanza kutumika.

2.2.2 Mkuu wa Wilaya alifika eneo la mradi tarehe 08/06/2025 kuzungumza na wananchi wa eneo husika kupitia mkutano wa hadhara.

2.2.3 Mkuu wa Wilaya alifika eneo la mradi tarehe 09/06/2025 kuzungumza na wanachi wa eneo husika.

2.2.4 Mkuu wa Wilaya Ubungo alifika eneo la mradi tarehe 16/09/2025 na kumsikiliza mlalamikaji kuhusu changamoto mbili alizowasilisha kutokana na utekelezaji wa mradi huo.

2.2.5 Kamati ya Usalama ilifika eneo la mradi tarehe 17/09/2025 na kumsikiliza mlalamikaji hata hivyo msimamo wake uliendelea kuwa ule ule.

2.2.6 Kamati ya Usalama ilifika eneo la Mtaa wa Mji Mpya Kata ya Kipawa tarehe 19/09/2025 na kuona mradi kama huo unapotekelezwa na katika ziara hiyo mradi huo unatekelezwa kwa teknologia ya ujenzi salama na hautofautiani na mfumo wa kawaida wa maji taka uliopo majumbani (Septic Tank and Soak away pit).

Kutokana na hali hiyo Ofisi ya Mkuu wa Wilaya inashauri maelekezo/ushauri wa kitaalamu ufuatwe kwani;

(1) Kwa kuzingatia eneo la Sinza linakabiliwa na changamoto kubwa ya mfumo wa uondoshaji wa maji taka, mradi huu ni suluhisho la tatizo hilo.

(2) Ushirikishwaji wa wananchi kuhusu mradi umefanyika kuanzia hatua ya awali kupitia vikao vya Mitaa na Kata hivyo mradi unakubalika na unaeleweka na umepokelewa vizuri na wananchi.

(3) Hakuna madhara yoyote ya kiafya yanayoweza kujitokeza kwa mujibu wa taarifa ya athari za afya na mazingira uliofanywa na Baraza la Mazingira (NEMC).

(4) Ofisi inaridhia mradi huu kuendelea kutekelezwa kutokana na manufaa yake kwa jamii kama yalivyoainishwa hapo juu.

Provision of the Design Service, Geotechnical Investigation, and Topographical Survey for the Construction of Simplified Sewers System (SSS) at Sinza "D" Area in Dar es Salaam

Second Water Sector Support Project
Ref No. TZ-DAWASA-118571-CS-QBS

SINZA "D" SIMPLIFIED SEWER NETWORK DESIGN REPORT

September 30, 2024

Designed by ELITE Solutions Ltd
for SHANXI Construction Engineering Corporation and Minerals Company.

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1 INTRODUCTION

This assignment is undertaken by the approved Elite Solutions Ltd (subcontractor) on behalf of SHANXI Construction Engineering Corporation and Minerals Company (Main Contractor) for the provision of the design service, geotechnical investigation, and topographical survey for the construction of simplified sewers system (SSS) at Sinza “D” Area in Dar es Salaam.

1.1 Project Overview

Dar es Salaam is the former capital of the United Republic of Tanzania and largest city with the highest population. Based on statistic information on the sanitation condition of Dar es Salaam, most of residents depends on on-site sanitation including pit latrines, septic tanks, and some open defecation. As identified by previous studies, existing off-grid system is not fully functioning and some intervention with additional financial investment can support to re-establish the chain of the sanitation in those area without proper sanitation service.

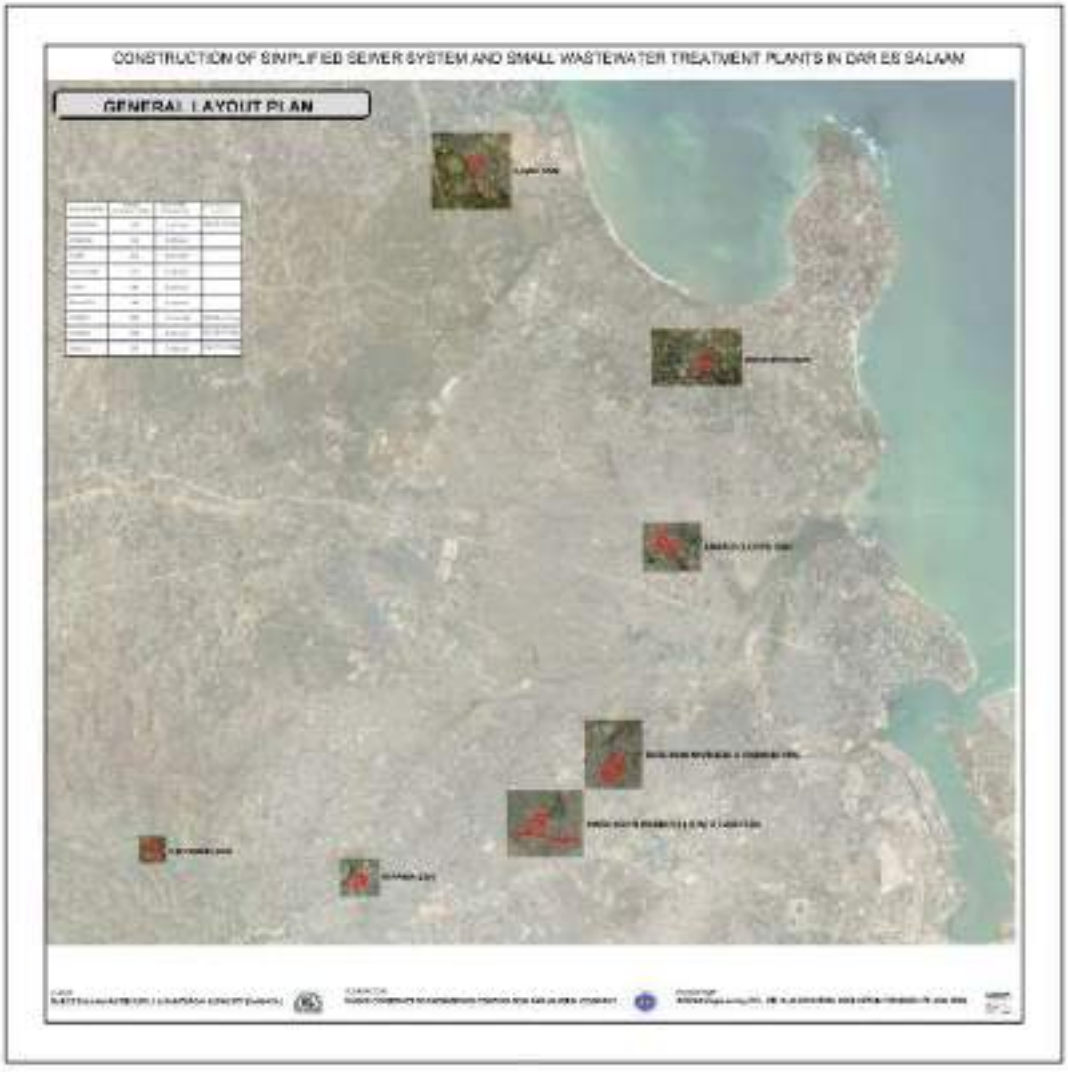


Figure 1 Project Site Map

The improvement in sanitation service can benefit to the population of the city with safe collection, treatment and disposal of the waste which are not currently contained, transported, treated, or disposed safely. Also, the public is burdened with expensive/unaffordable cost of pit emptying services and those collected faecal sludge are often emptied illegally into open drains, water

bodies, or into the environment. The resulted contamination of the environment, especially the groundwater, has led to occurrence of cholera outbreaks and other waterborne diseases in Dar es Salaam.

1.2 Project Objectives

The Second Water Sector Support Project (WSSPII) is developed to (a) strengthen the capacity for integrated water resources planning and management in United Republic of Tanzania, and (b) improve access to water supply and sanitation services in an operationally efficient manner in Dar es Salaam.

Outcome of the project will have an indirect benefit on a large number of beneficiaries in Sinza "D" area, Dar es Salaam, including urban and rural households, companies and public agencies, on the irrigation, tourism, mining, and fisheries sectors. In addition, strengthened institutional and regulatory frameworks, including implementation of comprehensive plans, will build an important foundation for efficient and harmonized utilization and protection of water resources.

The off-grid sanitation intervention proposed includes the shift away from unimproved toilet to improved ones, safe emptying and transportation of the waste to a treatment facility, and treatment and safe disposal of the waste into the environment. For sustainable sanitation service, a technology option suited for each area will also be applied. These technological interventions will include improved sanitation facilities at households, safe containment of faeces at household level, emptying the containment facilities in a safe and hygienic way, safe transportation, environmentally adequate treatment and disposal. The results expected from the Project is Design and construction of the Simplified Sewer System (SSS) at Sinza "D" Area.

1.3 Scope of the Assignment

The objective of this assignment is to prepare detailed designs and drawings and reports, towards supervising construction of the off-grid sanitation facility in Sinza "D" Area, Dar es Salaam City.

The Consultant is expected to consider decentralized technical solutions. The boundary of the sub-project will be based on local socio-economic, demographic and geographical conditions.

1.3.1 Simplified Sewerage Site

The System will be connected to the new wastewater treatment plant, Anaerobic Baffle Reactor (ABR) that is also part of this designed. The site information is as follows:

Table 1: Location of Simplified Sewerage Site

Sn	District	Name (Location)	Remarks
1	KInondoni	Sinza "D"	New treatment facility required for discharge

1.4 Purpose of this report

As described in the introduction above, one of the project components is Simplified Sewerage Networks. This sub-project will construct a Simplified Sewerage Networks located in Sinza "D" Kinondoni municipality. This report presents the design process of the Simplified Sewerage Network with its respective treatment facility. This report will also present the outcome of the detailed design work.

2 DESIGN METHODOLOGY

2.1 Site Selection and Confirmation Criteria

The Proposed Project Sites were Jointly checked: -

- Site Locations with respect to business land use, & buildings
- Soil type if allows shallow sewers
- Topography of the areas to allow gravity flow
- Access roads and paths to allow gravity routes of pipeline flows
- Availability of discharge/disposal of the wastewater
- Locally available of construction material

2.2 Topographical Survey

Topographical survey was conducted to the proposed site for simplified sewerage project locating all key features and levels of the selected site.

2.3 Simplified Sewerage Design Consideration

A shallow sewer system is a separate sewer system which utilizes gravity for conveying raw sewage from all households to an outlet downstream. It must be set deep enough to receive flows from each user but must be located so that this depth is kept to a minimum. It must have sufficient size and gradient to carry these flows. In addition, maintenance operations, public safety and convenience must be evaluated in the light of water availability and the potential for user participation.

Shallow depths must be maintained not only for economy in construction but also for facilitation of user maintenance. Frequent sewer flushing, achieved through the connection to a single sewer line of a number of houses, must be ensured for good operation. Pipes with sufficient structural strength must be used, and suitable bedding materials must be selected to withstand backfilling, and impact and live loads where these are likely to occur. The type and number of appurtenances used must facilitate cleaning of the sewers with the kinds of cleaning equipment likely to be used. Public convenience and safety during construction are additional important factors.

2.4 Estimation of Wastewater Generation

Wastewater generation was estimated basing on the per capita consumption of water supply of which 85% percent is converted into wastewater. The per capita consumption is considered as 60 liters/day as stated in the Design, Construction Supervision, Operation and Maintenance (DCOM) Manual; Volume II Design of Sanitation Projects (4th Edition), Ministry of Water (MoW), (March 2020) and confirmed from the household surveys conducted in each simplified sewerage site. The wastewater generated is further factored to have peak flows for pipeline design.

The peak flows are used in the simplified sewerage pipeline sizing while the average daily wastewater generated is used to size the treatment units in the areas without existing treatment discharge facility.

Table 2: Wastewater Generation

Project Site Name	Number of Household Present	Population Size *(Based on 5 people per household)*	Water Consumption (PLCD = 90lts) (m^3/day)	Extension reserve & surface water (Typical - 30%)	Average Daily Wastewater Generation, 85% of Water Supply (m^3/day)	Wastewater Peak Flows (Peak Factor = 1.8) (l/s),
Sinza "D"	300	1,500	135.0	20.4	149.4	2

2.5 Hydraulic Calculations for the Simplified Sewerage Pipelines

2.5.1 Simplified Sewerage System constituent parts

The simplified sewerage system is divided mainly in two parts, the condominium/block branch and the public/collector sewer. This division can be seen as follows:

Condominium/Block Branch: The Block Branch is the pipeline that collects all the wastewater produced within an urban block. It acts as a collective connection, connecting the domestic installation of each household of a block to the public collector sewer that passes along the block extremity.

Public/Collector sewer: Is the pipeline that collects the wastewater from the condominium/Block branches. This pipeline is always on the public area of the streets. It follows the last inspection box of each condominium/block branch, and is installed, if possible on the side walk of the streets. When this is not possible it will be installed at the road. When the public sewer passes along the face of a Block, no condominium branches are needed at this side of the block and connection are done directly into the public sewer.

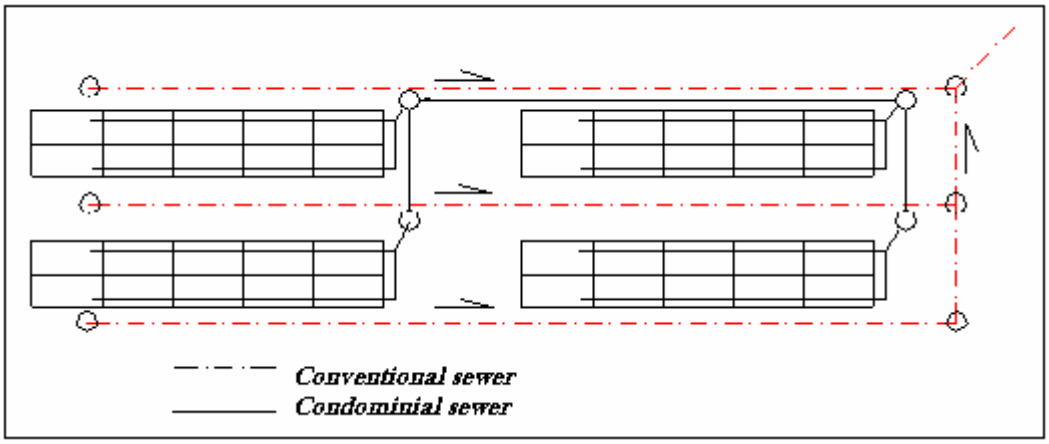


Figure 2 General layout of a condominium system

2.5.2 The Simplified System Main Characteristics

2.5.2.1 Minimum diameters

The minimum diameter adopted for the condominium system is 100 mm, both for the condominium/blocks branch as for the public sewer.

Table 3: Minimum Pipeline diameters

Sewer type	Minimum Diameter
Blocks Branch	100 mm
Public Sewer	100 mm

2.5.2.2 Minimum Pipe Coverage

The minimum coverage for the pipes is defined according to the position they are placed on the streets, in a way that is possible to lower the installation costs without the risk of causing damage to the pipes. In this way the minimum coverage adopted for the simplified sewerage system are presented in the Table 4 below:

Table 4: Minimum Pipe Coverage

Position of the pipes	Minimum Coverage
Traffic roads	0.65 m
Side walk	0.65 m
Inside of the lot	0.30 m

2.5.2.3 Minimum depth

The depth to install the pipes is the one that allows the gravity collection of all the wastewater and that permits the pipe to be protected against damage according to the minimum desired coverage. The minimum depth varies according to the position of the pipes in the street area. In a way to get always the lowest excavation volume, in all the situations where the natural slope of the ground is higher than the minimum required slope, the minimum depth is adopted.

Table 5: Minimum recommended depth

Sewer type	Minimum depth
Condominium/Block branch	0.40 m
Side walk public sewer	0.80 m
Traffic road sewer	0.80 m

2.5.2.4 Inspection Chambers

The inspection devices are the elements of the sewerage network that have the main objective of allowing access to the pipeline in order to permit its maintenance in the case of obstruction.

Inspection chambers are located in all of these situations:

- At the start of the branch
- At each time the condominium branch reaches 40 m of length
- At each time the public sewer reaches 40 m of length
- At the connection between the internal installation and the condominium branch.
- At any point where the pipe changes its direction or its slope
- At any point where, different upstream branches meet and discharge in the same downstream branch

In a simplified sewerage system, the following inspection devices are usually used:

- Condominium/Block branch, Inspection boxes type with internal width and length of 0.4m.

- Public/Collector sewer, Inspection boxes type with internal width and length of 0.6m.

2.5.2.5 Pipes Materials:

PVC pipes are recommended to use. PVC pipes offer excellent flow conditions.

2.5.2.6 Diameter and slope options:

For the simplified sewerage systems, the minimum slope of 0.5% and the minimum diameter of 100 mm are adopted for all the branches. A different slope is adopted only when the natural terrain slope is higher than the minimum slope.

2.5.3 Design Parameters

The choice of the design parameters has a significant impact on the systems cost, as they will define the size of the system to be constructed.

2.5.3.1 Wastewater return factor (k_2)

The wastewater return coefficient tries to represent the relationship between the water consume in a household and its correspondent wastewater production. The value of the wastewater return coefficient is usually less than one, and for this design a value of 0.85 is adopted.

$k_2 = 0.85$

2.5.3.2 "Per-capita" water demand (w):

The per - capita water consumption of a population depends on several factors, including cultural tradition, economic level, urban characteristics, climate, etc. Average water consumption of 60 L/person/day is used.

2.5.3.3 Peak Flow Factor (k_1):

As the flows determined by the water consume is an average value, the actual design of the system should consider the flow coefficients that try to correct these values to approximate the design flow to the values that will take place during the operation of the system. The peak flow factor is used to calculate the maximum and minimum flow that will occur in the pipe.

$k_1 = 1.80$

2.5.3.4 Daily Peak Flows (q):

The value of the wastewater flow used for sewer design is the daily peak flow. This can be estimated as follows;

$$q = \frac{k1.k2.P.w}{86400}$$

Where:

q = daily peak flow, l/s

k1 = peak factor (= daily peak flow divided by average daily flow)

k2 = return factor (= wastewater flow divided by water consumption)

P = population served by length of sewer under consideration

w = average water consumption, litres per person per day

86 400 is the number of seconds in a day

2.5.3.5 Flow Velocity (V):

The velocity is calculated using Gauckler-Manning equation by the formula below

$$q = \left(\frac{1}{n}\right) r^{2/3} s^{1/2}$$

Where:

V = velocity of flow at d/D

n = Ganguillet-Kutter roughness coefficient, dimensionless

r = hydraulic radius at d/D, m

s = sewer gradient, m/m (i.e. dimensionless)

The usual design value of the Gauckler roughness coefficient, n is 0.013. This value is used for any relatively smooth sewer pipe material including PVC, as it depends not so much on the roughness of the material itself, but on the roughness of the bacterial slime layer which grows on the sewer wall.

2.5.3.6 Design Criteria Summary

Table 6: Summary of Design Criteria

S/No	Items	Description
1	The minimum peak flow	1.5 L/s
2	The minimum self-cleansing velocity	0.5 m/s
3	The minimum gradient/slope of sewers	0.5% (1 in 200)
4	Minimum depth of block sewers	>= 40cm
5	Minimum depth of street collector sewer (Below sidewalks)	40 – 65 cm
6	Proposed pipe type	uPVC-PN6
7	Manhole type-1 for block sewers	400mm x 400mm
8	Manhole type-2 for street collector sewers	700mm x 700mm

Pipeline hydraulic results are presented in Appendix 1 of this report.

2.6 Hydraulic Calculations for the Wastewater Treatment Plants

As mentioned earlier, the proposed simplified sewerage site is without wastewater treatment plant, the design of the treatment plant is therefore considered. The average daily wastewater generated is used to size the treatment units.

The Table 7 below presents the facilities designed in each area

Table 7: Wastewater Treatment Facilities

S/No	Location	Facilities/Treatment Units	Treatment Capacity (m^3/day)	Remarks
1	Sinza ''D''	Anaerobic Baffle Reactor (ABR) and Anaerobic Filter (AF)	149.4	Area not available for wetland

2.6.1 Simulation model used to size ABR

$$COD_{te} = I_{in} - e^{-0.0553 * HRT} * X_{s,i}$$

Source: Guidelines for The Implementation of Anaerobic Baffled Reactors for on-Site or Decentralised Sanitation (K.M. Foxon and C.A. Buckley)

2.6.2 Simulation model used to size Wetland

$$\frac{C_o - C^*}{C_i - C^*} = \exp(-k_v HRT) \qquad \text{(Eq. 1)}$$

where Co = pollutant concentration at reed bed outlet (mg/L)
Ci = pollutant concentration at reed bed inlet (mg/L)
C* = background concentration due to return of pollutant (mg/L)

k_v = volumetric rate constant (d^{-1}) which varies with temperature according to Equation 2.

$$k_v = k_{v20}\theta^{(T-20)} \qquad \text{(Eq. 2)}$$

where k_{v20} = value of volumetric rate constant at 20°C
θ = temperature correction factor
T = water temperature (°C)

Source: Secondary treatment by reed bed – eight years experience in north eastern New South Wales Leigh Davison, Tom Headley and Katie Pratt

Detailed Hydraulic Calculations of the ABR are presented in Appendix 2 of this report.

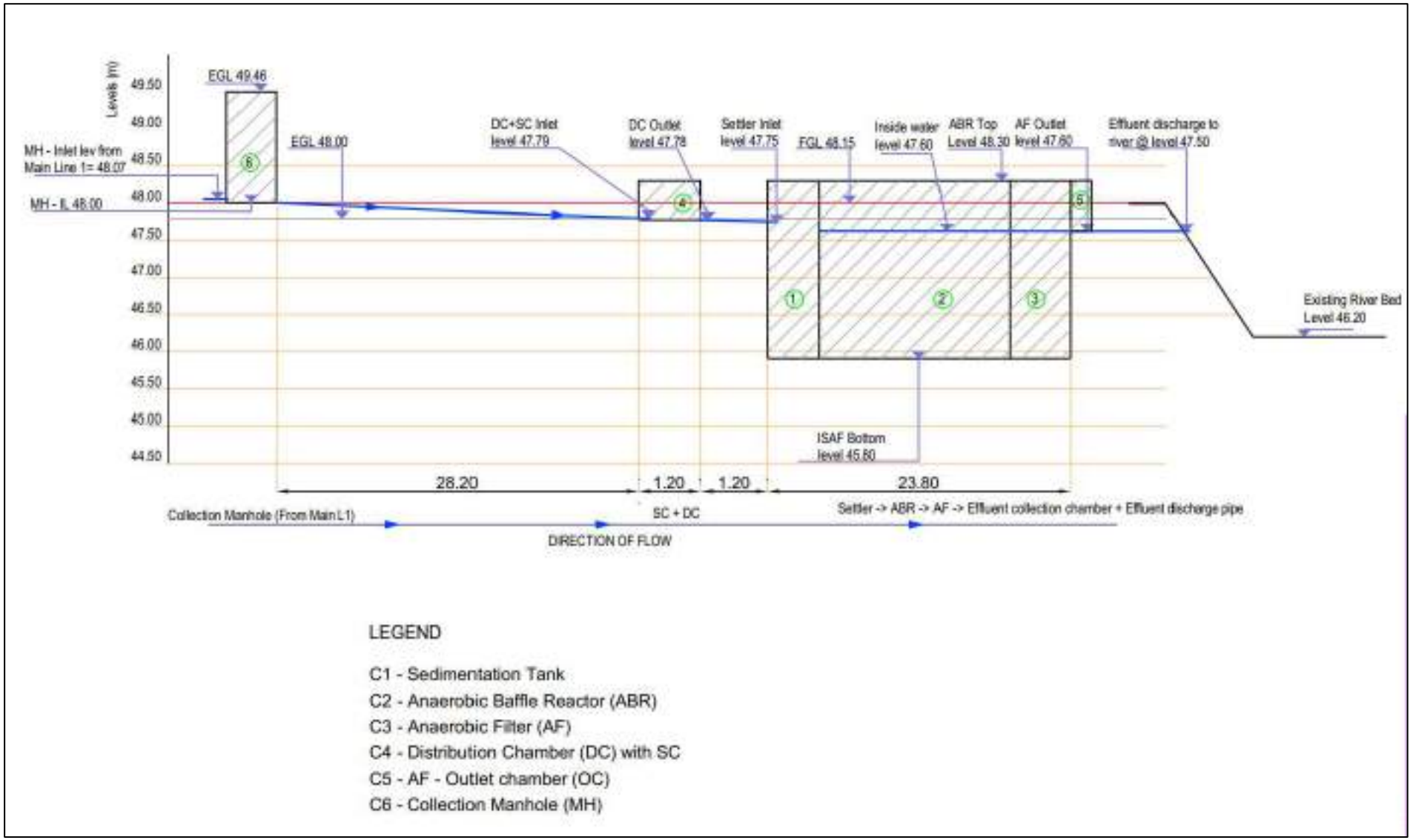


Figure 3 Schematic Diagram for Sinza "D" Treatment Plant

2.7 Geotechnical and Structural Analysis of the ABRs

Detailed report for geotechnical survey of this treatment site for the ABRs is presented as Appendices 3 in separate document.

Detailed structural analysis for each treatment of the ABRs is presented in Appendix 4 in separate document.

APPENDICES

Appendix 1 Pipeline Hydraulic Data for Simplified Sewerage Pipeline

FLOW ESTIMATE: Sinza "D" Simplified Sewer System

					Avg. No. of Persons Per House, N	*8*		*Peak Factor, k1*		*1.8*	
					Max. Water Consumption, w	*60 l/d*		*Minimum Velocity, v*		*0.5 m/s*	
					Return Factor, k2	*0.85*		*Minimum Peak Flow, Q*		*1.50 l/s*	
Collector Sewer Reference	**Manhole ID**		**Distance**	**Invert level**		**Number of Houses Served**			**Daily Peak Flow**	**Chainages**	
				Upstream	**Downstream**	**Current**	**Future**	**Design**			
C	**From**	**To**		**m**	**m**	**Nc**	**Nf**	**Nd**	**q (l/sec)**	**From**	**To**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
Line No 01 (Node 1 - Node 2)											
C1-1-1	3	MH1-2	16.257	53.94	53.86	4	0	4	0.034	0+000	0+016
C1-1-2	MH1-2	MH1-3	13.396	53.86	53.79	4	0	4	0.034	0+016	0+030
C1-1-3	MH1-3	MH1-4	9.063	53.79	53.43	1	0	1	0.009	0+030	0+039
C1-1-4	MH1-4	MH1-5	4.05	53.43	53.10	2	0	2	0.017	0+039	0+043
C1-1-5	MH1-5	MH1-6	11.518	53.10	52.98	3	0	3	0.026	0+043	0+054
C1-1-6	MH1-6	MH1-7	13.927	52.98	52.91	13	0	13	0.111	0+054	0+068
C1-1-7	MH1-7	MH1-8	29.497	52.91	52.61	1	0	1	0.009	0+068	0+098
C1-1-8	MH1-8	MH1-9	11.156	52.61	52.50	22	0	22	0.187	0+098	0+109
C1-1-9	MH1-9	MH1-10	18.203	52.50	52.32	1	0	1	0.009	0+109	0+127
C1-1-10	MH1-10	MH1-11	19.822	52.32	52.12	1	0	1	0.009	0+127	0+147
C1-1-11	MH1-11	MH1-12	39.135	52.12	51.73	1	0	1	0.009	0+000	0+186
C1-1-12	MH1-12	MH1-13	15.62	51.73	51.57	1	0	1	0.009	0+186	0+202
C1-1-13	MH1-13	MH1-14	5.114	51.57	51.55	1	0	1	0.009	0+202	0+207
C1-1-14	MH1-14	MH1-15	15.814	51.55	51.47	1	0	1	0.009	0+207	0+223
C1-1-15	MH1-15	MH1-16	11.425	51.47	51.41	2	0	2	0.017	0+223	0+234
C1-1-16	MH1-16	MH1-17	1.158	51.41	51.41	5	0	5	0.043	0+234	0+235
C1-1-17	MH1-17	MH1-18	8.825	51.41	51.36	1	0	1	0.009	0+235	0+244
C1-1-18	MH1-18	MH1-19	9.303	51.36	51.32	1	0	1	0.009	0+244	0+253
C1-1-19	MH1-19	MH1-20	3.629	51.32	51.30	1	0	1	0.009	0+253	0+257
C1-1-20	MH1-20	MH1-21	15.743	51.30	51.22	1	0	1	0.009	0+257	0+273
C1-1-21	MH1-21	MH1-22	10.806	51.22	51.16	1	0	1	0.009	0+000	0+283
C1-1-22	MH1-22	MH1-23	5.166	51.16	51.14	17	0	17	0.145	0+283	0+289
C1-1-23	MH1-23	MH1-24	16.388	51.14	51.06	1	0	1	0.009	0+289	0+305
C1-1-24	MH1-24	MH1-25	16.426	51.06	50.97	2	0	2	0.017	0+305	0+321
C1-1-25	MH1-25	MH1-26	5.973	50.97	50.94	11	0	11	0.094	0+321	0+327
C1-1-26	MH1-26	MH1-27	9.047	50.94	50.90	1	0	1	0.009	0+327	0+336
C1-1-27	MH1-27	MH1-28	9.483	50.90	50.85	3	0	3	0.026	0+336	0+346
C1-1-28	MH1-28	MH1-29	7.922	50.85	50.81	2	0	2	0.017	0+346	0+354
C1-2-1	MH1-29	MH1-30	19.534	50.81	50.71	2	0	2	0.017	0+354	0+373
C1-2-2	MH1-30	MH1-31	5.638	50.71	50.69	1	0	1	0.009	0+373	0+379
C1-2-3	MH1-31	MH1-32	11.044	50.69	50.63	1	0	1	0.009	0+000	0+390
C1-2-4	MH1-32	MH1-33	9.592	50.63	50.58	11	0	11	0.094	0+390	0+400
C1-2-5	MH1-33	MH1-34	20.806	50.58	50.48	3	0	3	0.026	0+400	0+420
C1-2-6	MH1-34	MH1-35	12.766	50.48	50.42	1	0	1	0.009	0+420	0+433
C1-2-7	MH1-35	MH1-36	4.909	50.42	50.39	34	0	34	0.289	0+433	0+438
C1-2-8	MH1-36	MH1-37	20.935	50.39	50.29	2	0	2	0.017	0+438	0+459
C1-2-9	MH1-37	MH1-38	10.341	50.29	50.23	1	0	1	0.009	0+459	0+469
C1-2-10	MH1-38	MH1-39	19.259	50.23	50.14	1	0	1	0.009	0+469	0+489
C1-2-11	MH1-39	MH1-40	25.965	50.14	50.01	0	0	0	0.000	0+489	0+515
C1-2-12	MH1-40	MH1-41	28.645	50.01	49.86	0	0	0	0.000	0+515	0+543
C1-2-13	MH1-41	MH1-42	20.941	49.86	49.76	0	0	0	0.000	0+147	0+564
C1-2-14	MH1-42	MH1-43	7.217	49.76	49.50	0	0	0	0.000	0+564	0+571
C1-2-15	MH1-43	MH1-44	13.169	49.50	49.04	0	0	0	0.000	0+571	0+585
C1-2-16	MH1-44	MH1-45	22.356	49.04	48.60	2	0	2	0.017	0+585	0+607
C1-2-17	MH1-45	MH1-46	7.264	48.60	48.56	0	0	0	0.000	0+607	0+614
C1-2-18	MH1-46	MH1-47	15.996	48.56	48.47	0	0	0	0.000	0+614	0+630
C1-3-1	MH1-47	MH1-48	13.72	48.47	48.39	0	0	0	0.000	0+630	0+644
C1-3-2	MH1-48	MH1-49	11.563	48.39	48.33	1	0	1	0.009	0+644	0+656
C1-3-3	MH1-49	MH1-50	5.527	48.33	48.30	1	0	1	0.009	0+656	0+661

					Avg. No. of Persons Per House, N	*8*		*Peak Factor, k1*		*1.8*	
					Max. Water Consumption, w	*60 l/d*		*Minimum Velocity, v*		*0.5 m/s*	
					Return Factor, k2	*0.85*		*Minimum Peak Flow, Q*		*1.50 l/s*	
Collector Sewer Reference	**Manhole ID**		**Distance**	**Invert level**		**Number of Houses Served**			**Daily Peak Flow**	**Chainages**	
				Upstream	**Downstream**	**Current**	**Future**	**Design**			
C	**From**	**To**		**m**	**m**	**Nc**	**Nf**	**Nd**	**q (l/sec)**	**From**	**To**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
C1-3-4	MH1-50	MH1-51	22.875	48.30	48.17	1	0	1	0.009	0+661	0+684
C1-3-5	MH1-51	MH1-52	9.928	48.17	48.12	11	0	11	0.094	0+684	0+694
C1-3-6	MH1-52	MH1-53	9.621	48.12	48.07	0	0	0	0.000	0+694	0+703
Sub Total						178	0	178	1.513		
Line No 02 (Node 3 - Node 4)											
C2-1-1	5	MH2-2	10.721	54.54	54.49	4	0	4	0.034	0+000	0+011
C2-1-2	MH2-2	MH2-3	17.533	54.49	54.40	0	0	0	0.000	0+011	0+028
C2-1-3	MH2-3	MH2-4	8.21	54.40	54.36	3	0	3	0.026	0+028	0+036
C2-1-4	MH2-4	MH2-5	20.247	54.36	54.16	33	0	33	0.281	0+036	0+057
C2-1-5	MH2-5	MH2-6	21.684	54.16	53.94	1	0	1	0.009	0+057	0+078
C2-1-6	MH2-6	MH2-7	7.798	53.94	53.86	6	0	6	0.051	0+078	0+086
C2-1-7	MH2-7	MH2-8	10.944	53.86	53.75	17	0	17	0.145	0+086	0+097
C2-1-8	MH2-8	MH2-9	21.016	53.75	53.54	0	0	0	0.000	0+097	0+118
C2-1-9	MH2-9	MH2-10	17.168	53.54	53.37	0	0	0	0.000	0+118	0+135
C2-1-10	MH2-10	MH2-11	8.692	53.37	53.28	1	0	1	0.009	0+135	0+144
C2-1-11	MH2-11	MH2-12	11.164	53.28	53.17	0	0	0	0.000	0+144	0+155
C2-1-12	MH2-12	MH2-13	8.937	53.17	53.08	1	0	1	0.009	0+155	0+164
C2-1-13	MH2-13	6	10.469	53.08	52.98	0	0	0	0.000	0+164	0+175
Total						66	0	66	0.561		
Line No 03 (Node 5 - Node 6)											
C3-1-1	7	MH3-2	0.044	54.05	54.05	1	0	1	0.009	0+000	0+000
C3-1-2	MH3-2	MH3-3	6.015	54.05	54.02	1	0	1	0.009	0+000	0+006
C3-1-3	MH3-3	MH3-4	8.592	54.02	53.30	1	0	1	0.009	0+006	0+015
C3-1-4	MH3-4	MH3-5	36.167	53.30	51.60	2	0	2	0.017	0+015	0+051
C3-1-5	MH3-5	MH3-6	20.737	51.60	51.44	0	0	0	0.000	0+051	0+072
C3-1-6	MH3-6	MH3-7	18.784	51.44	51.30	16	0	16	0.136	0+072	0+090
C3-1-7	MH3-7	MH3-8	22.856	51.30	51.13	50	0	50	0.425	0+090	0+113
C3-1-8	MH3-8	MH3-9	21.686	51.13	50.97	8	0	8	0.068	0+113	0+135
C3-1-9	MH3-9	MH3-10	11.913	50.97	50.88	0	0	0	0.000	0+135	0+147
C3-1-10	MH3-10	MH3-11	24.901	50.88	50.69	21	0	21	0.179	0+147	0+172
C3-1-11	MH3-11	MH3-12	17.986	50.69	50.56	0	0	0	0.000	0+172	0+190
C3-1-12	MH3-12	MH3-13	8.809	50.56	50.49	22	0	22	0.187	0+190	0+198
C3-1-13	MH3-13	MH3-14	6.523	50.49	50.44	0	0	0	0.000	0+198	0+205
C3-1-14	MH3-14	MH3-15	22.502	50.44	50.30	5	0	5	0.043	0+205	0+228
C3-1-15	MH3-15	8	33.419	50.30	50.05	0	0	0	0.000	0+228	0+261
Total						127	0	127	1.080		
Line No 04 (Node 7 - Node 8)											
C4-1-1	9	MH4-2	19.014	54.64	54.53	7	0	7	0.060	0+000	0+019
C4-1-2	MH4-2	MH4-3	23.303	54.53	54.40	0	0	0	0.000	0+019	0+042
C4-1-3	MH4-3	MH4-4	12.501	54.40	53.50	0	0	0	0.000	0+042	0+055
C4-1-4	MH4-4	MH4-5	16.407	53.50	52.60	0	0	0	0.000	0+055	0+071
C4-1-5	MH4-5	MH4-6	17.523	52.60	52.49	0	0	0	0.000	0+071	0+089
C4-1-6	MH4-6	MH4-7	15.692	52.49	52.20	1	0	1	0.009	0+089	0+104
C4-1-7	MH4-7	MH4-8	12.332	52.20	51.50	1	0	1	0.009	0+104	0+117
C4-1-8	MH4-8	MH4-9	15.178	51.50	51.10	1	0	1	0.009	0+117	0+132
C4-1-9	MH4-9	MH4-10	22.771	51.10	50.97	0	0	0	0.000	0+132	0+155
C4-1-10	MH4-10	MH4-11	11.022	50.97	50.91	2	0	2	0.017	0+155	0+166
C4-1-11	MH4-11	MH4-12	23.865	50.91	50.77	0	0	0	0.000	0+166	0+190
C4-1-12	MH4-12	MH4-13	14.665	50.77	50.69	1	0	1	0.009	0+000	0+204
C4-1-13	MH4-13	MH4-14	13.814	50.69	50.61	1	0	1	0.009	0+204	0+218
C4-1-14	MH4-14	MH4-15	5.988	50.61	50.28	11	0	11	0.094	0+218	0+224

					Avg. No. of Persons Per House, N	*8*		*Peak Factor, k1*		*1.8*	
					Max. Water Consumption, w	*60 l/d*		*Minimum Velocity, v*		*0.5 m/s*	
					Return Factor, k2	*0.85*		*Minimum Peak Flow, Q*		*1.50 l/s*	
Collector Sewer Reference	**Manhole ID**		**Distance**	**Invert level**		**Number of Houses Served**			**Daily Peak Flow**	**Chainages**	
				Upstream	**Downstream**	**Current**	**Future**	**Design**			
C	**From**	**To**		**m**	**m**	**Nc**	**Nf**	**Nd**	**q (l/sec)**	**From**	**To**
1	**2**	**3**		**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
C4-1-15	MH4-15	MH4-16	13.877	50.28	50.18	0	0	0	0.000	0+224	0+238
C4-1-16	MH4-16	MH4-17	11.571	50.18	50.10	4	0	4	0.034	0+238	0+250
C4-1-17	MH4-17	MH4-18	8.917	50.10	50.04	0	0	0	0.000	0+250	0+258
C4-1-18	MH4-18	MH4-19	18.644	50.04	49.91	1	0	1	0.009	0+258	0+277
C4-1-19	MH4-19	MH4-20	15.016	49.91	49.80	0	0	0	0.000	0+277	0+292
C4-1-20	MH4-20	MH4-21	5.299	49.80	49.76	0	0	0	0.000	0+292	0+297
C4-1-21	MH4-21	MH4-22	34.885	49.76	49.51	0	0	0	0.000	0+297	0+332
C4-2-1	MH4-22	MH4-23	6.974	49.51	49.45	1	0	1	0.009	0+332	0+339
C4-2-2	MH4-23	MH4-24	7.2	49.45	49.41	1	0	1	0.009	0+000	0+346
C4-2-3	MH4-24	MH4-25	18.126	49.41	49.28	0	0	0	0.000	0+346	0+365
C4-2-4	MH4-25	MH4-26	3.822	49.28	49.25	7	0	7	0.060	0+365	0+368
C4-2-5	MH4-26	MH4-27	3.64	49.25	49.23	0	0	0	0.000	0+368	0+372
C4-2-6	MH4-27	MH4-28	4.03	49.23	49.21	0	0	0	0.000	0+372	0+376
C4-2-7	MH4-28	MH4-29	12.101	49.21	49.13	2	0	2	0.017	0+376	0+388
C4-2-8	MH4-29	MH4-30	20.372	49.13	48.98	3	0	3	0.026	0+388	0+409
C4-2-9	MH4-30	MH4-31	14.101	48.98	48.88	1	0	1	0.009	0+409	0+423
C4-2-10	MH4-31	MH4-32	9.366	48.88	48.82	0	0	0	0.000	0+423	0+432
C4-2-11	MH4-32	MH4-33	22.671	48.82	48.65	1	0	1	0.009	0+432	0+455
C4-2-12	MH4-33	MH4-34	8.908	48.65	48.59	2	0	2	0.017	0+455	0+464
Total						48	0	48	0.102		

HYDRAULIC DESIGN CALCULATIONS FOR SINZA "D" SIMPLIFIED SEWER SYSTEM

Sewer Reference	Length	Number of houses served	Daily Peak Flow Upstream	Flow along the stretch	Actual Flow down stream	Flow down stream	Invert level		Diference in invert level	Gradient	Manning	Diameter	Diameter	Diameter	Diameter	Flow at full section	Velocity of flow	Remark
							Upstream	Downstream										
C	m	Nd	L/sec	L/sec	L/sec	q (L/sec)	m	m	m	%	n	mm	mm	mm	m	Q (L/sec)	v (m/s)	
1	2	3	4	5	6	7	8	9	10	11	12			13		14	15	16
Line No 01 (Node 1 - Node 2)																		
C1-1-1	16.257	4	0.000	0.034	0.034	1.500	53.94	53.86	0.08	0.50%	0.013	111	150	150	0.150	5.939	0.5	Node 1
C1-1-2	13.396	4	0.034	0.034	0.068	1.500	53.86	53.79	0.07	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-3	9.063	1	0.068	0.009	0.077	1.500	53.79	53.43	0.37	4.04%	0.013	23	100	100	0.100	5.726	1.1	
C1-1-4	4.05	2	0.077	0.017	0.094	1.500	53.43	53.10	0.33	8.05%	0.013	14	100	100	0.100	8.083	1.6	
C1-1-5	11.518	3	0.094	0.026	0.119	1.500	53.10	52.98	0.12	1.07%	0.013	63	100	100	0.100	2.947	0.6	
C1-1-6	13.927	13	0.119	0.111	0.230	1.500	52.98	52.91	0.07	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-7	29.497	1	0.230	0.009	0.238	1.500	52.91	52.61	0.29	1.00%	0.013	66	100	100	0.100	2.849	0.6	
C1-1-8	11.156	22	0.238	0.187	0.425	1.500	52.61	52.50	0.11	0.99%	0.013	67	100	100	0.100	2.835	0.6	
C1-1-9	18.203	1	0.425	0.009	0.434	1.500	52.50	52.32	0.18	1.00%	0.013	66	100	100	0.100	2.849	0.6	
C1-1-10	19.822	1	0.434	0.009	0.442	1.500	52.32	52.12	0.20	1.00%	0.013	66	100	100	0.100	2.849	0.6	
C1-1-11	186.024	1	0.442	0.009	0.451	1.500	52.12	51.73	0.39	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-12	15.62	1	0.451	0.009	0.459	1.500	51.73	51.57	0.16	1.00%	0.013	66	100	100	0.100	2.849	0.6	
C1-1-13	5.114	1	0.459	0.009	0.468	1.500	51.57	51.55	0.03	0.51%	0.013	110	150	150	0.150	5.998	0.5	
C1-1-14	15.814	1	0.468	0.009	0.476	1.500	51.55	51.47	0.08	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-15	11.425	2	0.476	0.017	0.493	1.500	51.47	51.41	0.06	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-16	1.158	5	0.493	0.043	0.536	1.500	51.41	51.41	0.01	0.52%	0.013	108	150	150	0.150	6.057	0.5	
C1-1-17	8.825	1	0.536	0.009	0.544	1.500	51.41	51.36	0.04	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-18	9.303	1	0.544	0.009	0.553	1.500	51.36	51.32	0.05	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-19	3.629	1	0.553	0.009	0.561	1.500	51.32	51.30	0.02	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-10	19.822	1	0.561	0.009	0.570	1.500	52.32	52.12	0.20	1.00%	0.013	66	100	100	0.100	2.849	0.6	
C1-1-21	283.461	1	0.570	0.009	0.578	1.500	51.22	51.16	0.05	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-22	5.166	17	0.578	0.145	0.723	1.500	51.16	51.14	0.03	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-23	16.388	1	0.723	0.009	0.731	1.500	51.14	51.06	0.08	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-24	16.426	2	0.731	0.017	0.748	1.500	51.06	50.97	0.08	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-25	5.973	11	0.748	0.094	0.842	1.500	50.97	50.94	0.03	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-26	9.047	1	0.842	0.009	0.850	1.500	50.94	50.90	0.05	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-27	9.483	3	0.850	0.026	0.876	1.500	50.90	50.85	0.05	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-1-28	7.922	2	1.437	0.017	1.454	1.500	50.85	50.81	0.04	0.50%	0.013	111	150	150	0.150	5.939	0.5	Node 4
C1-2-1	19.534	2	1.454	0.017	1.471	1.500	50.81	50.71	0.10	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-2	5.638	1	1.471	0.009	1.479	1.500	50.71	50.69	0.03	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-13	417.352	0	1.479	0.000	1.479	1.500	49.86	49.76	0.10	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-4	9.592	11	1.479	0.094	1.573	1.573	50.63	50.58	0.05	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-5	20.806	3	1.573	0.026	1.598	1.598	50.58	50.48	0.10	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-6	12.766	1	1.598	0.009	1.607	1.607	50.48	50.42	0.06	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-7	4.909	34	1.607	0.289	1.896	1.896	50.42	50.39	0.03	0.51%	0.013	110	150	150	0.150	5.998	0.5	
C1-2-8	20.935	2	1.896	0.017	1.913	1.913	50.39	50.29	0.10	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-9	10.341	1	1.913	0.009	1.921	1.921	50.29	50.23	0.05	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-10	19.259	1	1.921	0.009	1.930	1.930	50.23	50.14	0.10	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-11	25.965	0	1.930	0.000	1.930	1.930	50.14	50.01	0.13	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-12	28.645	0	1.930	0.000	1.930	1.930	50.01	49.86	0.14	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-13	417.352	0	1.930	0.000	1.930	1.930	49.86	49.76	0.10	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C1-2-14	7.217	0	1.930	0.000	1.930	1.930	49.76	49.50	0.26	3.62%	0.013	25	100	100	0.100	5.420	1.1	

Sewer Reference	Length	Number of houses served	Daily Peak Flow Upstream	Flow along the stretch	Actual Flow down stream	Flow down stream	Invert level		Diference in invert level	Gradient	Manning	Diameter	Diameter	Diameter	Diameter	Flow at full section	Velocity of flow	Remark
							Upstream	Downstream										
C	m	Nd	L/sec	L/sec	L/sec	q (L/sec)	m	m	m	%	n	mm	mm	mm	m	Q (L/sec)	v (m/s)	
1	2	3	4	5	6	7	8	9	10	11	12			13		14	15	16
C1-2-15	13.169	0	1.930	0.000	1.930	1.930	49.50	49.04	0.46	3.48%	0.013	26	100	100	0.100	5.315	1.1	
C1-2-16	22.356	2	1.930	0.017	1.947	1.947	49.04	48.60	0.44	1.99%	0.013	40	100	100	0.100	4.019	0.8	
C1-2-17	7.264	0	1.947	0.000	1.947	1.947	48.60	48.56	0.04	0.55%	0.013	104	150	150	0.150	6.229	0.6	
C1-2-18	15.996	0	4.055	0.000	4.055	4.055	48.56	48.47	0.09	0.55%	0.013	104	150	150	0.150	6.229	0.6	Node 8
C1-3-1	13.72	0	4.055	0.000	4.055	4.055	48.47	48.39	0.08	0.55%	0.013	104	150	150	0.150	6.229	0.6	
C1-3-2	11.563	1	4.055	0.009	4.063	4.063	48.39	48.33	0.06	0.55%	0.013	104	150	150	0.150	6.229	0.6	
C1-3-3	5.527	1	4.063	0.009	4.072	4.072	48.33	48.30	0.03	0.54%	0.013	105	150	150	0.150	6.172	0.5	
C1-3-4	22.875	1	4.072	0.009	4.080	4.080	48.30	48.17	0.13	0.55%	0.013	104	150	150	0.150	6.229	0.6	
C1-3-5	9.928	11	4.080	0.094	4.174	4.174	48.17	48.12	0.05	0.55%	0.013	104	150	150	0.150	6.229	0.6	
C1-3-6	9.621	0	4.174	0.000	4.174	4.174	48.12	48.07	0.05	0.55%	0.013	104	150	150	0.150	6.229	0.6	Node 2
Sub Total	1929.82	177																
Line No 02 (Node 3 - Node 4)																		
C2-1-1	10.721	4	0.000	0.034	0.034	1.500	54.54	54.49	0.05	0.50%	0.013	111	150	150	0.150	5.939	0.5	Node 3
C2-1-2	17.533	0	0.034	0.000	0.034	1.500	54.49	54.40	0.09	0.51%	0.013	110	150	150	0.150	5.998	0.5	
C2-1-3	8.21	3	0.034	0.026	0.060	1.500	54.40	54.36	0.04	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C2-1-4	20.247	33	0.060	0.281	0.340	1.500	54.36	54.16	0.20	0.99%	0.013	67	100	150	0.100	2.835	0.6	
C2-1-5	21.684	1	0.340	0.009	0.349	1.500	54.16	53.94	0.22	1.01%	0.013	66	100	150	0.100	2.863	0.6	
C2-1-6	7.798	6	0.349	0.051	0.400	1.500	53.94	53.86	0.08	1.03%	0.013	65	100	150	0.100	2.891	0.6	
C2-1-7	10.944	17	0.400	0.145	0.544	1.500	53.86	53.75	0.11	1.01%	0.013	66	100	150	0.100	2.863	0.6	
C2-1-8	21.016	0	0.544	0.000	0.544	1.500	53.75	53.54	0.21	1.00%	0.013	66	100	150	0.100	2.849	0.6	
C2-1-9	17.168	0	0.544	0.000	0.544	1.500	53.54	53.37	0.17	0.99%	0.013	67	100	150	0.100	2.835	0.6	
C2-1-10	8.692	1	0.544	0.009	0.553	1.500	53.37	53.28	0.09	1.04%	0.013	64	100	150	0.100	2.905	0.6	
C2-1-11	11.164	0	0.553	0.000	0.553	1.500	53.28	53.17	0.11	0.99%	0.013	67	100	150	0.100	2.835	0.6	
C2-1-12	8.937	1	0.553	0.009	0.561	1.500	53.17	53.08	0.09	1.01%	0.013	66	100	150	0.100	2.863	0.6	
C2-1-13	10.469	0	0.561	0.000	0.561	1.500	53.08	52.98	0.10	0.96%	0.013	68	100	150	0.100	2.791	0.6	Node 4
Total	174.583	66																
Line No 03 (Node 5 - Node 6)																		
C3-1-1	0.044	1	0.000	0.009	0.009	1.500	54.05	54.05	0.00	0.50%	0.013	111	150	150	0.150	5.939	0.5	Node 5
C3-1-2	6.015	1	0.009	0.009	0.017	1.500	54.05	54.02	0.03	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C3-1-3	8.592	1	0.017	0.009	0.026	1.500	54.02	53.30	0.72	8.38%	0.013	13	100	100	0.100	8.247	1.6	
C3-1-4	36.167	2	0.026	0.017	0.043	1.500	53.30	51.60	1.70	4.70%	0.013	21	100	100	0.100	6.176	1.2	
C3-1-5	20.737	0	0.043	0.000	0.043	1.500	51.60	51.44	0.16	0.77%	0.013	81	100	100	0.100	2.500	0.5	
C3-1-6	18.784	16	0.043	0.136	0.179	1.500	51.44	51.30	0.14	0.75%	0.013	82	100	150	0.100	2.467	0.5	
C3-1-7	22.856	50	0.179	0.425	0.604	1.500	51.30	51.13	0.17	0.74%	0.013	83	100	100	0.100	2.451	0.5	
C3-1-8	18.784	16	0.604	0.136	0.740	1.500	51.44	51.30	0.14	0.75%	0.013	82	100	100	0.100	2.467	0.5	
C3-1-9	22.856	50	0.740	0.425	1.165	1.500	51.30	51.13	0.17	0.74%	0.013	83	100	100	0.100	2.451	0.5	
C3-1-10	21.686	8	1.165	0.068	1.233	1.500	51.13	50.97	0.16	0.74%	0.013	83	100	100	0.100	2.451	0.5	
C3-1-11	11.913	0	1.233	0.000	1.233	1.500	50.97	50.88	0.09	0.76%	0.013	81	100	150	0.100	2.484	0.5	
C3-1-12	24.901	21	1.233	0.179	1.411	1.500	50.88	50.69	0.19	0.76%	0.013	81	100	100	0.100	2.484	0.5	
C3-1-13	17.986	0	1.411	0.000	1.411	1.500	50.69	50.56	0.13	0.72%	0.013	85	100	150	0.100	2.417	0.5	
C3-1-14	21.686	8	1.411	0.068	1.479	1.500	51.13	50.97	0.16	0.74%	0.013	83	100	150	0.100	2.451	0.5	
C3-1-15	22.502	5	1.479	0.043	1.522	1.522	50.44	50.30	0.13	0.58%	0.013	100	100	150	0.100	2.170	0.4	
#REF!	24.901	21	1.522	0.179	1.700	1.700	50.88	50.69	0.19	0.76%	0.013	81	100	150	0.100	2.484	0.5	Node 6
Total	300.41	200																
Line No 04 (Node 7 - Node 8)																		
C4-1-1	19.014	7	0.000	0.060	0.060	1.500	54.64	54.53	0.11	0.58%	0.013	100	100	150	0.100	2.170	0.4	Node 7

Sewer Reference	Length	Number of houses served	Daily Peak Flow Upstream	Flow along the stretch	Actual Flow down stream	Flow down stream	Invert level		Diference in invert level	Gradient	Manning	Diameter	Diameter	Diameter	Diameter	Flow at full section	Velocity of flow	Remark
							Upstream	Downstream										
C	m	Nd	L/sec	L/sec	L/sec	q (L/sec)	m	m	m	%	n	mm	mm	mm	m	Q (L/sec)	v (m/s)	
1	2	3	4	5	6	7	8	9	10	11	12			13		14	15	16
C4-1-2	23.303	0	0.060	0.000	0.060	1.500	54.53	54.40	0.13	0.56%	0.013	102	150	150	0.150	6.286	0.6	
C4-1-3	12.501	0	0.060	0.000	0.060	1.500	54.40	53.50	0.90	7.20%	0.013	15	100	100	0.100	7.644	1.5	
C4-1-4	16.407	0	0.060	0.000	0.060	1.500	53.50	52.60	0.90	5.49%	0.013	18	100	100	0.100	6.675	1.3	
C4-1-5	17.523	0	0.060	0.000	0.060	1.500	52.60	52.49	0.11	0.63%	0.013	94	100	100	0.100	2.261	0.4	
C4-1-6	15.692	1	0.060	0.009	0.068	1.500	52.49	52.20	0.29	1.85%	0.013	42	100	150	0.100	3.875	0.8	
C4-1-7	12.332	1	0.068	0.009	0.077	1.500	52.20	51.50	0.70	5.68%	0.013	18	100	100	0.100	6.790	1.4	
C4-1-8	15.178	1	0.077	0.009	0.085	1.500	51.50	51.10	0.40	2.64%	0.013	32	100	100	0.100	4.629	0.9	
C4-1-9	22.771	0	0.085	0.000	0.085	1.500	51.10	50.97	0.13	0.57%	0.013	101	150	100	0.150	6.342	0.6	
C4-1-10	11.022	2	0.085	0.017	0.102	1.500	50.97	50.91	0.06	0.54%	0.013	105	150	100	0.150	6.172	0.5	
C4-1-11	23.865	0	0.102	0.000	0.102	1.500	50.91	50.77	0.14	0.59%	0.013	98	100	150	0.100	2.188	0.4	
C4-1-12	204.273	1	0.102	0.009	0.111	1.500	50.77	50.69	0.08	0.50%	0.013	111	150	100	0.150	5.939	0.5	
C4-1-13	13.814	1	0.111	0.009	0.119	1.500	50.69	50.61	0.08	0.58%	0.013	100	100	150	0.100	2.170	0.4	
C4-1-14	5.988	11	0.119	0.094	0.213	1.500	50.61	50.28	0.33	5.51%	0.013	18	100	150	0.100	6.687	1.3	
C4-1-15	13.877	0	0.213	0.000	0.213	1.500	50.28	50.18	0.10	0.72%	0.013	85	100	150	0.100	2.417	0.5	
C4-1-16	11.571	4	0.213	0.034	0.247	1.500	50.18	50.10	0.08	0.69%	0.013	88	100	150	0.100	2.366	0.5	
C4-1-17	8.917	0	0.247	0.000	0.247	1.500	50.10	50.04	0.06	0.67%	0.013	90	100	150	0.100	2.332	0.5	
C4-1-18	18.644	1	0.247	0.009	0.255	1.500	50.04	49.91	0.13	0.70%	0.013	87	100	150	0.100	2.384	0.5	
C4-1-19	15.016	0	0.255	0.000	0.255	1.500	49.91	49.80	0.11	0.73%	0.013	84	100	150	0.100	2.434	0.5	
C4-1-20	5.299	0	0.255	0.000	0.255	1.500	49.80	49.76	0.04	0.75%	0.013	82	100	100	0.100	2.467	0.5	
C4-1-21	34.885	0	1.955	0.000	1.955	1.955	49.76	49.51	0.25	0.72%	0.013	85	100	150	0.100	2.417	0.5	Node 6
C4-2-1	6.974	1	1.955	0.009	1.964	1.964	49.51	49.45	0.05	0.72%	0.013	85	100	150	0.100	2.417	0.5	
C4-2-2	346.458	1	1.964	0.009	1.972	1.972	49.45	49.41	0.04	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C4-2-3	18.126	0	1.972	0.000	1.972	1.972	49.41	49.28	0.13	0.72%	0.013	85	100	150	0.100	2.417	0.5	
C4-2-4	3.822	7	1.972	0.060	2.032	2.032	49.28	49.25	0.03	0.78%	0.013	80	100	150	0.100	2.516	0.5	
C4-2-5	3.64	0	2.032	0.000	2.032	2.032	49.25	49.23	0.02	0.55%	0.013	104	150	150	0.150	6.229	0.6	
C4-2-6	4.03	0	2.032	0.000	2.032	2.032	49.23	49.21	0.02	0.50%	0.013	111	150	150	0.150	5.939	0.5	
C4-2-7	12.101	2	2.032	0.017	2.049	2.049	49.21	49.13	0.08	0.66%	0.013	91	100	150	0.100	2.314	0.5	
C4-2-8	20.372	3	2.049	0.026	2.074	2.074	49.13	48.98	0.15	0.74%	0.013	83	100	150	0.100	2.451	0.5	
C4-2-9	14.101	1	2.074	0.009	2.083	2.083	48.98	48.88	0.10	0.71%	0.013	86	100	150	0.100	2.401	0.5	
C4-2-10	9.366	0	2.083	0.000	2.083	2.083	48.88	48.82	0.06	0.64%	0.013	93	100	150	0.100	2.279	0.5	
C4-2-11	22.671	1	2.083	0.009	2.091	2.091	48.82	48.65	0.17	0.75%	0.013	82	100	150	0.100	2.467	0.5	
C4-2-12	8.908	2	2.091	0.017	2.108	2.108	48.65	48.59	0.06	0.67%	0.013	90	100	150	0.100	2.332	0.5	Node 8
Total	189.608	12																

Appendix 2: Hydraulic Calculation for Wastewater treatment plant

Project:	PROPOSED WASTEWATER TREATMENT AT SINZA "D"
Object:	Design of Wastewater treatment at Sinza "D"
Terms:	Design parameter
Date:	21-Aug-24

1. Treatment capacity			l/unit/d	m³/d
Source	**unit**			
Residents	1500		90	135.0
Extension reserve	30%		0	40.8
Water consumption				175.8
Wastewater generation	85%		77	149.4
Calculation base	**1500**			**149.4**

2.1 Inflow schedule					
Peak Flow Factor				2.0	
Peak Flow				12.5	m³/h
2.2 Peak flow		10.0	l/h/cap	15.0	m³/h
		0.004	l/s/cap	6.0	l/s
		9.5		**15.7**	

3. Wastewater parameter				SS	BOD		COD	
		l/cap/d	m³/d	kg/d	kg/d	mg/l	kg/d	mg/l
Black water	30%	0.0	44.8	22.5	45.0	1,004	59.4	1,325
Gray water	70%	0.0	104.6	4.5	9.0	86	9.0	86
Inflow Settler	**100%**	**0.0**	**149.4**	**27.0**	**54**	**361**	**68.4**	**458**
Effluent AF			**149.4**	**1.35**		**36**		**58**

4. Design parameter		
average flow	2.0	m³/h
peak flow	12.5	m³/h
Average Temp.	23	°C

5. Remark:

The treatment plant is designed to treat domestic and organic wastewater. For maximum treatment performance sand and grease traps have to be installed before treatment units, if required according to site conditions.

The effluent quality can only be achieved under following conditions:

1) 4-6 months after plant is in operation

The wastewater to be treated is purely domestic wastewater without containing foreign matters like chemicals and mineral oil

3) Operated according O&M manual

4) Constructed according given quality standards and layout design

5) The system is design for certain maximal hydraulic flow and number people to be connected. A permanent hydraulic overloading will reduce and might also break down the treatment performances. Uncontrolled infiltration of storm water into sewer manholes and/or uncontrolled extension of house connection is often the reason and has to be avoided

Project: PROPOSED WASTEWATER TREATMENT AT SINZA "D"
Object: Design of Wastewater treatment at Sinza "D"
Terms: Layout settler
Doc.Nr. L05
Date: 21/ Aug/ 24

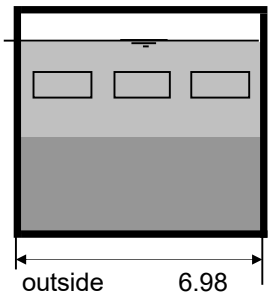
General spread scheet for two-chamber settler (ST)

daily waste water flow		COD inflow	BOD_5 inflow	HRT inside tank	settleable SS / COD inflow	settleable SS / COD outflow	COD outflow	BOD_5 outflow
given		**given**	**given**	**chosen**	**given**	calcul.	calcul.	calcul.
m³/day		mg/l	mg/l	h	mg/l / mg/l	mg/l / mg/l	mg/l	mg/l
149.4		**458**	**361**	2.0	**0.55**	0.30	282	221
		COD/BOD_5 ->	1.27	*1,5-2,0 h*	*0,4-0,55 domestic*		*BODrem.->*	1.007

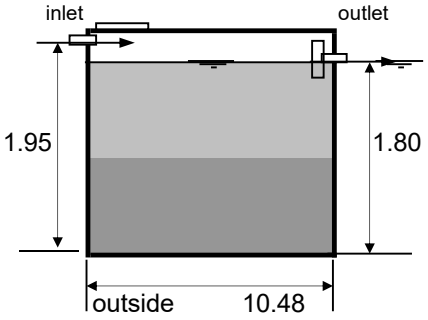
dimensions

de-sludging interval	max flow at peak hours	inner width of septic tank	minimum water depth at outlet point	inner length of chamber		volume incl. sludge	actual volume of septic tank	COD removal rate
chosen	calcul.	**chosen**	**chosen**	requir.	**chosen**	requir.	**check !**	calcul.
months	m³/h	m	m	m	m	m³	m³	%
12	12.45	**6.50**	**1.80**	4.81	**10.00**	56.26	117.00	39%
					sludge l/g BODrem.	0.0042		

cross section



longitudinal section



Project: **PROPOSED WASTEWATER TREATMENT AT SINZA "D"**
Object: **Design of wastewater treatment at Sinza "D"**
Terms: **Layout ABR**
Date: **21/ Aug/ 24**

General spread sheet for baffled reactor

general data

avg. daily waste water flow	Pre-Treatment		COD inflow	BOD_5 inflow	lowest digester temp.
given	Biogas	Septic Tank	**given**	**given**	**given**
m^3/day			mg/l	mg/l	°C
149.4	0	1	**282**	**221**	**23**
			COD/BOD ratio	1.28	

dimensions

water depth at outlet	length of chambers		length of downflow shaft	width of chambers		number of upflow chambers
chosen	required	**chosen**	chosen	required	**chosen**	**chosen**
m	m	m	m	**min.!**	m	No.
1.80	0.72	**3.10**	0.00	6.02	6.50	5
			min 12 cm, or 0 in case of down pipes			

intermediate and secondary results

upflow velocity *best below 1 m/h*	factors to calculate BOD removal rate of baffled reactor					BOD rem rate calcul. by factors	max peak flow per hour	actual upflow velocity	actual volume of baffled reactor	HRT in baffled tank	org. load (BOD_5)	biogas (ass: CH_4 assumed%; 50% dissolved)
chosen	calculated according to graphs					69%	**max.!**	calcul.	calcul.	calcul.	calcul.	calcul.
m/h	f-overload	f-strength	f-temp	f-chamb.	f-HRT	applied	m^3/h	m/h	m^3	h	kg/m^3*d	m^3/d
1	1.00	0.72	0.94	1.01	1.00	69%	18.68	0.93	181.35	28	0.55	24.29
							16.00					

procedure of calculation

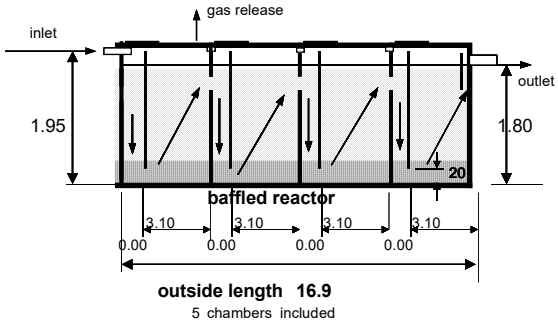
1. Fill in all figures in bold (until A12) 2. Check your effluent quality whether CODout or BODout is sufficient. 3. Check whether the total length of the tank suits your site. 4. If the result is not satisfying increase or reduce the number of chambers

treatment efficiency

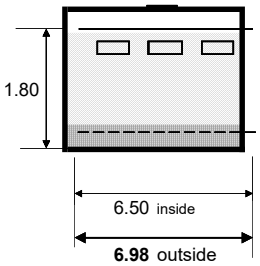
total BOD_5 rem.rate	COD / BOD removal factor	total COD rem.rate	COD out	BOD out
calcul.	calcul.	calcul.	calcul.	calcul.
%		%	mg/l	mg/l
68%	1.11	62%	107	70

principal longitudinal section

4 baffled tanks are shown, actual number chosen is **5**



cross section



Project: **PROPOSED WASTEWATER TREATMENT AT SINZA "D"**
Object: Design of Wastewater treatment at Sinza "D"
Terms: Layout AF
Doc.Nr. L07
Date: 21/ Aug/ 24

Anaerobic Filter (AF)

general data

daily waste water flow		COD inflow	BOD_5 inflow		lowest digester temper.
given		**given**	**given**		**given**
m³/day		mg/l	mg/l		°C
149.4		**107**	**70**		**23**
		COD/BOD_5			
		1.54			

dimensions

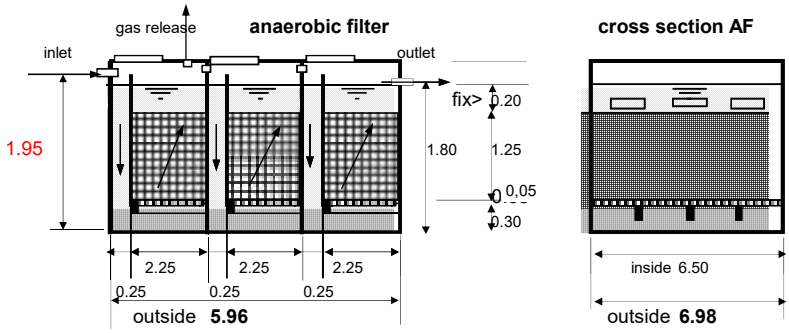
specific surface of filter medium	voids in filter mass	depth of filter tanks	length of each tank	number of filter tanks	width of filter tanks = ABR
given	**given**	**chosen**	**chosen**	**chosen**	**taken**
m²/m³	**%**	m	m	No.	m
120	45%	**1.80**	**2.25**	**2**	**6.50**
range	*range*		**cal.max**		
120	*30-45*		1.80		

treatment data

HRT inside AF reactor	max. velocity in filter voids	factors to calculate COD removal rate of anaerobic filter						COD removal rate	BOD_5 removal rate	COD outflow of AF	BOD_5 outflow of AF
check!	**check !**	calculated according to graphs						calcul.	calcul.	calcul.	calcul.
h	m/h	f-temp	f-load	f-strength	f-surface	f-HRT	f-chamb.	%	%	mg/l	mg/l
5.2	2.84	0.94	1.00	0.79	1.11	0.51	1.08	46%	49%	58	36
normal	*max.*										
24 - 48 h	*2.00*										

intermediate calculations

max. peak flow per hour	BOD/COD rem. Factor AF	org.load on AF COD	filter height	net volume of filter tanks	**biogas pro-duction**
calcul.	calc.	calcul.	calcul.	calcul.	calcul.
m³/h	ratio	kg/m³*d	m	m³	m³/d
18.68	1.06	0.30	1.25	32.54	1.83



Appendix 3: Geotechnical Report for Sinza “D” Treatment Site

THIS IS ISSUED AS A SEPARATE DOCUMENT THAT FORMS PART OF THIS REPORT

Appendix 4: Structural Calculations for Anaerobic Baffle Reactors

CONSTRUCTION OF FAECAL SLUDGE TREATMENT PLANTS

(FSTP) WORKS IN DAR ES SALAAM

FAECAL SLUDGE TREATMENT PLANT - SMALL SIZE (50m³) SINZA D FSTP - INTERGRATED SETTLER, ABR & ANAEROBIC FILTER

STRUCTURAL DESIGN REVIEW REPORT

CLIENT

DAR ES SALAAM WATER SUPPLY & SANITATION AUTHORITY (DAWASA)

CONSULTANTS

DOHWA Engineering CO., LTD IN ASSOCIATION WITH LUPTAN CONSULTS LTD AND WWS

CONTRACTOR

SHANXI CONSTRUCTION ENGINEERING CORPORATION AND MINERAL COMPANY

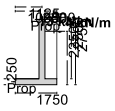
Sept, 2024

SHANXI CONSTRUCTION ENGINEERING CORPORATION AND MINERAL COMPANY	**PROJECT:** **CONSTRUCTION OF FAECAL SLUDGE TREATMENT PLANTS (FSTP) WORKS IN DAR ES SALAAM**	
	DESIGN TITLE: ANAEROBIC BAFFLE REACTOR	**DESIGN BY: O.M**
	CHECKED BY: G.N	**DATE:** Sept 2024

Reference	Calculations	Results
	ANAEROBIC BAFFLE REACTOR STRUCTURAL DESIGN	

SHANXI CONSTRUCTION ENGINEERING CORPORATION AND MINERAL COMPANY	**PROJECT:** **CONSTRUCTION OF FAECAL SLUDGE TREATMENT PLANTS (FSTP) WORKS IN DAR ES SALAAM**	
	DESIGN TITLE: ANAEROBIC BAFFLE REACTOR	**DESIGN BY: O.M**
	CHECKED BY: G.N	**DATE:** Sept 2024

RETAINING WALL ANALYSIS (BS 8002:1994)



Wall details

Retaining wall type;	**Cantilever propped at both**
Height of retaining wall stem;	h_{stem} = **2500** mm
Thickness of wall stem;	t_{wall} = **250** mm
Length of toe;	l_{toe} = **1000** mm
Length of heel;	l_{heel} = **500** mm
Overall length of base;	$l_{base} = l_{toe} + l_{heel} + t_{wall}$ = **1750** mm
Thickness of base;	t_{base} = **250** mm
Depth of downstand;	d_{ds} = **0** mm
Position of downstand;	l_{ds} = **600** mm
Thickness of downstand;	t_{ds} = **250** mm
Height of retaining wall;	$h_{wall} = h_{stem} + t_{base} + d_{ds}$ = **2750** mm
Depth of cover in front of wall;	d_{cover} = **0** mm
Depth of unplanned excavation;	d_{exc} = **0** mm
Height of ground water behind wall;	h_{water} = **2250** mm
Height of saturated fill above base;	$h_{sat} = \max(h_{water} - t_{base} - d_{ds}, 0\ mm)$ = **2000** mm
Density of wall construction;	g_{wall} = **23.6** kN/m^3
Density of base construction;	g_{base} = **23.6** kN/m^3

SHANXI CONSTRUCTION ENGINEERING CORPORATION AND MINERAL COMPANY	**PROJECT:** **CONSTRUCTION OF FAECAL SLUDGE TREATMENT PLANTS (FSTP) WORKS IN DAR ES SALAAM**	
	DESIGN TITLE: ANAEROBIC BAFFLE REACTOR	**DESIGN BY: O.M**
	CHECKED BY: G.N	**DATE:** Sept 2024

Angle of rear face of wall; a = **90.0** deg

Angle of soil surface behind wall; b = **0.0** deg

Effective height at virtual back of wall; $h_{eff} = h_{wall} + l_{heel} \times \tan(b)$ = **2750** mm

Retained material details

Mobilisation factor; M = **2.0**

Moist density of retained material; g_m = **17.0** kN/m^3

Saturated density of retained material; g_s = **19.0** kN/m^3

Design shear strength; f' = **18.6** deg

Angle of wall friction; d = **14.2** deg

Base material details

Firm clay

Moist density; g_{mb} = **18.0** kN/m^3

Design shear strength; f'_b = **24.2** deg

Design base friction; d_b = **18.6** deg

Allowable bearing pressure; $P_{bearing}$ = **200** kN/m^2

Using Coulomb theory

Active pressure coefficient for retained material

$$K_a = \sin(a + f')^2 / (\sin(a)^2 \times \sin(a - d) \times [1 + \sqrt{(\sin(f' + d) \times \sin(f' - b) / (\sin(a - d) \times \sin(a + b)))]}^2) = \mathbf{0.458}$$

Passive pressure coefficient for base material

$$K_p = \sin(90 - f'_b)^2 / (\sin(90 - d_b) \times [1 - \sqrt{(\sin(f'_b + d_b) \times \sin(f'_b) / (\sin(90 + d_b)))]}^2) = \mathbf{4.187}$$

At-rest pressure

At-rest pressure for retained material; $K_0 = 1 - \sin(f')$ = **0.681**

Loading details

Surcharge load on plan; Surcharge = **4.0** kN/m^2

Applied vertical dead load on wall; W_{dead} = **10.3** kN/m

Applied vertical live load on wall; W_{live} = **3.0** kN/m

Position of applied vertical load on wall; l_{load} = **1125** mm

Applied horizontal dead load on wall; F_{dead} = **0.0** kN/m

Applied horizontal live load on wall; F_{live} = **0.0** kN/m

Height of applied horizontal load on wall; h_{load} = **0** mm

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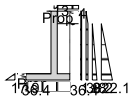
	CHECKED BY: G.N	**DATE:** Sept 2024



Loads shown in kN/m, pressures shown in kN/m^2

Vertical forces on wall

Wall stem; $w_{wall} = h_{stem} \cdot t_{wall} \cdot g_{wall}$ = **14.8** kN/m

Wall base; $w_{base} = l_{base} \cdot t_{base} \cdot g_{base}$ = **10.3** kN/m

Surcharge; w_{sur} = Surcharge $\cdot l_{heel}$ = **2** kN/m

Moist backfill to top of wall; $w_{m\_w} = l_{heel} \cdot (h_{stem} - h_{sat}) \cdot g_m$ = **4.3** kN/m

Saturated backfill; $w_s = l_{heel} \cdot h_{sat} \cdot g_s$ = **19** kN/m

Applied vertical load; $W_v = W_{dead} + W_{live}$ = **13.3** kN/m

Total vertical load; $W_{total} = w_{wall} + w_{base} + w_{sur} + w_{m\_w} + w_s + W_v$ = **63.6** kN/m

Horizontal forces on wall

Surcharge; $F_{sur} = K_a \cdot \cos(90 - a + d) \cdot$ Surcharge $\cdot h_{eff}$ = **4.9** kN/m

Moist backfill above water table; $F_{m\_a} = 0.5 \cdot K_a \cdot \cos(90 - a + d) \cdot g_m \cdot (h_{eff} - h_{water})^2$ = **0.9** kN/m

Moist backfill below water table; $F_{m\_b} = K_a \cdot \cos(90 - a + d) \cdot g_m \cdot (h_{eff} - h_{water}) \cdot h_{water}$ = **8.5** kN/m

Saturated backfill; $F_s = 0.5 \cdot K_a \cdot \cos(90 - a + d) \cdot (g_s - g_{water}) \cdot h_{water}^2$ = **10.3** kN/m

Water; $F_{water} = 0.5 \cdot h_{water}^2 \cdot g_{water}$ = **24.8** kN/m

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Total horizontal load; $F_{total} = F_{sur} + F_{m\_a} + F_{m\_b} + F_s + F_{water}$ = **49.5** kN/m

Calculate total propping force

Passive resistance of soil in front of wall; $F_p = 0.5 \cdot K_p \cdot \cos(d_b) \cdot (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \cdot g_{mb}$ = **2.2** kN/m

Propping force; $F_{prop} = \max(F_{total} - F_p - (W_{total} - w_{sur} - W_{live}) \times \tan(d_b), 0$ kN/m)

F_{prop} = **27.5** kN/m

Overturning moments

Surcharge; $M_{sur} = F_{sur} \cdot (h_{eff} - 2 \cdot d_{ds}) / 2$ = **6.7** kNm/m

Moist backfill above water table; $M_{m\_a} = F_{m\_a} \cdot (h_{eff} + 2 \cdot h_{water} - 3 \cdot d_{ds}) / 3$ = **2.3** kNm/m

Moist backfill below water table; $M_{m\_b} = F_{m\_b} \cdot (h_{water} - 2 \cdot d_{ds}) / 2$ = **9.6** kNm/m

Saturated backfill; $M_s = F_s \cdot (h_{water} - 3 \cdot d_{ds}) / 3$ = **7.7** kNm/m

Water; $M_{water} = F_{water} \cdot (h_{water} - 3 \cdot d_{ds}) / 3$ = **18.6** kNm/m

Total overturning moment; $M_{ot} = M_{sur} + M_{m\_a} + M_{m\_b} + M_s + M_{water}$ = **44.9** kNm/m

Restoring moments

Wall stem; $M_{wall} = w_{wall} \cdot (l_{toe} + t_{wall} / 2)$ = **16.6** kNm/m

Wall base; $M_{base} = w_{base} \cdot l_{base} / 2$ = **9** kNm/m

Surcharge; $M_{sur\_r} = w_{sur} \cdot (l_{base} - l_{heel} / 2)$ = **3** kNm/m

Moist backfill; $M_{m\_r} = (w_{m\_w} \cdot (l_{base} - l_{heel} / 2) + w_{m\_s} \cdot (l_{base} - l_{heel} / 3))$ = **6.4** kNm/m

Saturated backfill; $M_{s\_r} = w_s \cdot (l_{base} - l_{heel} / 2)$ = **28.5** kNm/m

Design vertical load; $M_v = W_v \cdot l_{load}$ = **15** kNm/m

Total restoring moment; $M_{rest} = M_{wall} + M_{base} + M_{sur\_r} + M_{m\_r} + M_{s\_r} + M_v$ = **78.5** kNm/m

Check bearing pressure

Total vertical reaction; $R = W_{total}$ = **63.6** kN/m

Distance to reaction; $x_{bar} = l_{base} / 2$ = **875** mm

Eccentricity of reaction; $e = \text{abs}((l_{base} / 2) - x_{bar})$ = **0** mm

Reaction acts within middle third of base

Bearing pressure at toe; $p_{toe} = (R / l_{base}) - (6 \cdot R \cdot e / l_{base}^2)$ = **36.4** kN/m^2

Bearing pressure at heel; $p_{heel} = (R / l_{base}) + (6 \cdot R \cdot e / l_{base}^2)$ = **36.4** kN/m^2

PASS - Maximum bearing pressure is less than allowable bearing pressure

Calculate propping forces to top and base of wall

Propping force to top of wall

$F_{prop\_top} = (M_{ot} - M_{rest} + R \cdot l_{base} / 2 - F_{prop} \cdot t_{base} / 2) / (h_{stem} + t_{base} / 2)$ = **7.121** kN/m

Propping force to base of wall; $F_{prop\_base} = F_{prop} - F_{prop\_top}$ = **20.404** kN/m

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RETAINING WALL DESIGN (BS 8002:1994)

Ultimate limit state load factors

Dead load factor; g_{f_d} = **1.4**

Live load factor; g_{f_l} = **1.6**

Earth and water pressure factor; g_{f_e} = **1.4**

Factored vertical forces on wall

Wall stem; $w_{wall\_f} = g_{f\_d} \cdot h_{stem} \cdot t_{wall} \cdot g_{wall}$ = **20.7** kN/m

Wall base; $w_{base\_f} = g_{f\_d} \cdot l_{base} \cdot t_{base} \cdot g_{base}$ = **14.5** kN/m

Surcharge; $w_{sur\_f} = g_{f\_l} \cdot \text{Surcharge} \cdot l_{heel}$ = **3.2** kN/m

Moist backfill to top of wall; $w_{m\_w\_f} = g_{f\_d} \cdot l_{heel} \cdot (h_{stem} - h_{sat}) \cdot g_m$ = **6** kN/m

Saturated backfill; $w_{s\_f} = g_{f\_d} \cdot l_{heel} \cdot h_{sat} \cdot g_s$ = **26.6** kN/m

Applied vertical load; $W_{v\_f} = g_{f\_d} \cdot W_{dead} + g_{f\_l} \cdot W_{live}$ = **19.2** kN/m

Total vertical load; $W_{total\_f} = w_{wall\_f} + w_{base\_f} + w_{sur\_f} + w_{m\_w\_f} + w_{s\_f} + W_{v\_f}$

= **90.1** kN/m

Factored horizontal at-rest forces on wall

Surcharge; $F_{sur\_f} = g_{f\_l} \cdot K_0 \cdot \text{Surcharge} \cdot h_{eff}$ = **12** kN/m

Moist backfill above water table; $F_{m\_a\_f} = g_{f\_e} \cdot 0.5 \cdot K_0 \cdot g_m \cdot (h_{eff} - h_{water})^2$ = **2** kN/m

Moist backfill below water table; $F_{m\_b\_f} = g_{f\_e} \cdot K_0 \cdot g_m \cdot (h_{eff} - h_{water}) \cdot h_{water}$ = **18.2** kN/m

Saturated backfill; $F_{s\_f} = g_{f\_e} \cdot 0.5 \cdot K_0 \cdot (g_s - g_{water}) \cdot h_{water}^2$ = **22.2** kN/m

Water; $F_{water\_f} = g_{f\_e} \cdot 0.5 \cdot h_{water}^2 \cdot g_{water}$ = **34.8** kN/m

Total horizontal load; $F_{total\_f} = F_{sur\_f} + F_{m\_a\_f} + F_{m\_b\_f} + F_{s\_f} + F_{water\_f}$ = **89.2** kN/m

Calculate total propping force

Passive resistance of soil in front of wall; $F_{p\_f} = g_{f\_e} \cdot 0.5 \cdot K_p \cdot \cos(d_b) \cdot (d_{cover} + t_{base} + d_{ds} - d_{exc})^2 \cdot g_{mb}$ = **3.1** kN/m

Propping force; $F_{prop\_f} = \max(F_{total\_f} - F_{p\_f} - (W_{total\_f} - w_{sur\_f} - g_{f\_l} \cdot W_{live}) \times \tan(d_b), 0$ kN/m)

F_{prop_f} = **58.4** kN/m

Factored overturning moments

Surcharge; $M_{sur\_f} = F_{sur\_f} \cdot (h_{eff} - 2 \cdot d_{ds}) / 2$ = **16.5** kNm/m

Moist backfill above water table; $M_{m\_a\_f} = F_{m\_a\_f} \cdot (h_{eff} + 2 \cdot h_{water} - 3 \cdot d_{ds}) / 3$ = **4.9** kNm/m

Moist backfill below water table; $M_{m\_b\_f} = F_{m\_b\_f} \cdot (h_{water} - 2 \cdot d_{ds}) / 2$ = **20.5** kNm/m

Saturated backfill; $M_{s\_f} = F_{s\_f} \cdot (h_{water} - 3 \cdot d_{ds}) / 3$ = **16.6** kNm/m

Water; $M_{water\_f} = F_{water\_f} \cdot (h_{water} - 3 \cdot d_{ds}) / 3$ = **26.1** kNm/m

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Total overturning moment; $M_{ot\_f} = M_{sur\_f} + M_{m\_a\_f} + M_{m\_b\_f} + M_{s\_f} + M_{water\_f}$ = **84.6** kNm/m

Restoring moments

Wall stem; $M_{wall\_f} = w_{wall\_f} \cdot (l_{toe} + t_{wall} / 2)$ = **23.2** kNm/m

Wall base; $M_{base\_f} = w_{base\_f} \cdot l_{base} / 2$ = **12.6** kNm/m

Surcharge; $M_{sur\_r\_f} = w_{sur\_f} \cdot (l_{base} - l_{heel} / 2)$ = **4.8** kNm/m

Moist backfill; $M_{m\_r\_f} = (w_{m\_w\_f} \cdot (l_{base} - l_{heel} / 2) + w_{m\_s\_f} \cdot (l_{base} - l_{heel} / 3))$ = **8.9** kNm/m

Saturated backfill; $M_{s\_r\_f} = w_{s\_f} \cdot (l_{base} - l_{heel} / 2)$ = **39.9** kNm/m

Design vertical load; $M_{v\_f} = W_{v\_f} \cdot l_{load}$ = **21.6** kNm/m

Total restoring moment; $M_{rest\_f} = M_{wall\_f} + M_{base\_f} + M_{sur\_r\_f} + M_{m\_r\_f} + M_{s\_r\_f} + M_{v\_f}$ = **111.1** kNm/m

Factored bearing pressure

Total vertical reaction; $R_f = W_{total\_f}$ = **90.1** kN/m

Distance to reaction; $x_{bar\_f} = l_{base} / 2$ = **875** mm

Eccentricity of reaction; $e_f = abs((l_{base} / 2) - x_{bar\_f})$ = **0** mm

Reaction acts within middle third of base

Bearing pressure at toe; $p_{toe\_f} = (R_f / l_{base}) - (6 \cdot R_f \cdot e_f / l_{base}^2)$ = **51.5** kN/m^2

Bearing pressure at heel; $p_{heel\_f} = (R_f / l_{base}) + (6 \cdot R_f \cdot e_f / l_{base}^2)$ = **51.5** kN/m^2

Rate of change of base reaction; $rate = (p_{toe\_f} - p_{heel\_f}) / l_{base}$ = **0.00** kN/m^2/m

Bearing pressure at stem / toe; $p_{stem\_toe\_f} = max(p_{toe\_f} - (rate \cdot l_{toe}), 0\ kN/m^2)$ = **51.5** kN/m^2

Bearing pressure at mid stem; $p_{stem\_mid\_f} = max(p_{toe\_f} - (rate \cdot (l_{toe} + t_{wall} / 2)), 0$ kN/m^2) = **51.5** kN/m^2

Bearing pressure at stem / heel; $p_{stem\_heel\_f} = max(p_{toe\_f} - (rate \cdot (l_{toe} + t_{wall})), 0\ kN/m^2)$ = **51.5** kN/m^2

Calculate propping forces to top and base of wall

Propping force to top of wall

$$F_{prop\_top\_f} = (M_{ot\_f} - M_{rest\_f} + R_f \cdot l_{base} / 2 - F_{prop\_f} \cdot t_{base} / 2) / (h_{stem} + t_{base} / 2)$$ = **17.136** kN/m

Propping force to base of wall; $F_{prop\_base\_f} = F_{prop\_f} - F_{prop\_top\_f}$ = **41.309** kN/m

<u>Design of reinforced concrete retaining wall toe (BS 8002:1994)</u>

Material properties

Characteristic strength of concrete; f_{cu} = **25** N/mm^2

Characteristic strength of reinforcement; f_y = **460** N/mm^2

Base details

Minimum area of reinforcement; k = **0.13** %

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Cover to reinforcement in toe; c_{toe} = **30** mm

Calculate shear for toe design

Shear from bearing pressure; $V_{toe\_bear} = (p_{toe\_f} + p_{stem\_toe\_f}) \times l_{toe} / 2$ = **51.5** kN/m

Shear from weight of base; $V_{toe\_wt\_base} = g_{f\_d} \times g_{base} \times l_{toe} \times t_{base}$ = **8.3** kN/m

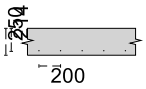
Total shear for toe design; $V_{toe} = V_{toe\_bear} - V_{toe\_wt\_base}$ = **43.2** kN/m

Calculate moment for toe design

Moment from bearing pressure; $M_{toe\_bear} = (2 \times p_{toe\_f} + p_{stem\_mid\_f}) \times (l_{toe} + t_{wall} / 2)^2 / 6$ = **32.6** kNm/m

Moment from weight of base; $M_{toe\_wt\_base} = (g_{f\_d} \times g_{base} \times t_{base} \times (l_{toe} + t_{wall} / 2)^2 / 2)$ = **5.2** kNm/m

Total moment for toe design; $M_{toe} = M_{toe\_bear} - M_{toe\_wt\_base}$ = **27.3** kNm/m



Check toe in bending

Width of toe; b = **1000** mm/m

Depth of reinforcement; $d_{toe} = t_{base} - c_{toe} - (f_{toe} / 2)$ = **214.0** mm

Constant; $K_{toe} = M_{toe} / (b \times d_{toe}^2 \times f_{cu})$ = **0.024**

Compression reinforcement is not required

Lever arm; $z_{toe} = \min(0.5 + \sqrt{}(0.25 - (\min(K_{toe}, 0.225) / 0.9)), 0.95) \times d_{toe}$

z_{toe} = **203** mm

Area of tension reinforcement required; $A_{s\_toe\_des} = M_{toe} / (0.87 \times f_y \times z_{toe})$ = **336** mm²/m

Minimum area of tension reinforcement; $A_{s\_toe\_min} = k \times b \times t_{base}$ = **325** mm²/m

Area of tension reinforcement required; $A_{s\_toe\_req} = \text{Max}(A_{s\_toe\_des}, A_{s\_toe\_min})$ = **336** mm²/m

Reinforcement provided; **12 mm dia.bars @ 200 mm centres**

Area of reinforcement provided; $A_{s\_toe\_prov}$ = **565** mm²/m

PASS - Reinforcement provided at the retaining wall toe is adequate

Check shear resistance at toe

Design shear stress; $v_{toe} = V_{toe} / (b \times d_{toe})$ = **0.202** N/mm²

Allowable shear stress; $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ N/mm^2)}, 5) \times 1\ N/mm^2 =$ **4.000** N/mm^2

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress; $v_{c\_toe} =$ **0.474** N/mm^2

$v_{toe} < v_{c\_toe}$ - No shear reinforcement required

Design of reinforced concrete retaining wall heel (BS 8002:1994)

Material properties

Characteristic strength of concrete; $f_{cu} =$ **25** N/mm^2

Characteristic strength of reinforcement; $f_y =$ **460** N/mm^2

Base details

Minimum area of reinforcement; k = **0.13** %

Cover to reinforcement in heel; $c_{heel} =$ **30** mm

Calculate shear for heel design

Shear from bearing pressure; $V_{heel\_bear} = (p_{heel\_f} + p_{stem\_heel\_f}) \times l_{heel} / 2 =$ **25.7** kN/m

Shear from weight of base; $V_{heel\_wt\_base} = g_{f\_d} \times g_{base} \times l_{heel} \times t_{base} =$ **4.1** kN/m

Shear from weight of moist backfill; $V_{heel\_wt\_m} = w_{m\_w\_f} =$ **6** kN/m

Shear from weight of saturated backfill; $V_{heel\_wt\_s} = w_{s\_f} =$ **26.6** kN/m

Shear from surcharge; $V_{heel\_sur} = w_{sur\_f} =$ **3.2** kN/m

Total shear for heel design; $V_{heel} = - V_{heel\_bear} + V_{heel\_wt\_base} + V_{heel\_wt\_m} + V_{heel\_wt\_s} +$ $V_{heel\_sur} =$ **14.1** kN/m

Calculate moment for heel design

Moment from bearing pressure; $M_{heel\_bear} = (2 \times p_{heel\_f} + p_{stem\_mid\_f}) \times (l_{heel} + t_{wall} / 2)^2 / 6$ = **10.1** kNm/m

Moment from weight of base; $M_{heel\_wt\_base} = (g_{f\_d} \times g_{base} \times t_{base} \times (l_{heel} + t_{wall} / 2)^2 / 2) =$ **1.6** kNm/m

Moment from weight of moist backfill; $M_{heel\_wt\_m} = w_{m\_w\_f} \times (l_{heel} + t_{wall}) / 2 =$ **2.2** kNm/m

Moment from weight of saturated backfill; $M_{heel\_wt\_s} = w_{s\_f} \times (l_{heel} + t_{wall}) / 2 =$ **10** kNm/m

Moment from surcharge; $M_{heel\_sur} = w_{sur\_f} \times (l_{heel} + t_{wall}) / 2 =$ **1.2** kNm/m

Total moment for heel design; $M_{heel} = - M_{heel\_bear} + M_{heel\_wt\_base} + M_{heel\_wt\_m} +$ $M_{heel\_wt\_s} + M_{heel\_sur} =$ **5** kNm/m

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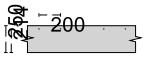

Check heel in bending

Width of heel; b = **1000** mm/m

Depth of reinforcement; $d_{heel} = t_{base} - c_{heel} - (f_{heel} / 2)$ = **214.0** mm

Constant; $K_{heel} = M_{heel} / (b \times d_{heel}^2 \times f_{cu})$ = **0.004**

Compression reinforcement is not required

Lever arm; $z_{heel} = \min(0.5 + \sqrt{}(0.25 - (\min(K_{heel}, 0.225) / 0.9)),0.95) \times d_{heel}$

z_{heel} = **203** mm

Area of tension reinforcement required; $A_{s\_heel\_des} = M_{heel} / (0.87 \times f_y \times z_{heel})$ = **61** mm²/m

Minimum area of tension reinforcement; $A_{s\_heel\_min} = k \times b \times t_{base}$ = **325** mm²/m

Area of tension reinforcement required; $A_{s\_heel\_req} = \text{Max}(A_{s\_heel\_des}, A_{s\_heel\_min})$ = **325** mm²/m

Reinforcement provided; **12 mm dia.bars @ 200 mm centres**

Area of reinforcement provided; $A_{s\_heel\_prov}$ = **565** mm²/m

PASS - Reinforcement provided at the retaining wall heel is adequate

Check shear resistance at heel

Design shear stress; $v_{heel} = V_{heel} / (b \times d_{heel})$ = **0.066** N/mm²

Allowable shear stress; $v_{adm} = \min(0.8 \times \sqrt{}(f_{cu} / 1\ \text{N/mm}^2), 5) \times 1\ \text{N/mm}^2$ = **4.000** N/mm²

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress; v_{c_heel} = **0.474** N/mm²

$v_{heel} < v_{c\_heel}$ - No shear reinforcement required

Design of reinforced concrete retaining wall stem (BS 8002:1994)

Material properties

Characteristic strength of concrete; f_{cu} = **25** N/mm²

Characteristic strength of reinforcement; f_y = **460** N/mm²

SHANXI CONSTRUCTION ENGINEERING CORPORATION AND MINERAL COMPANY	**PROJECT:** **CONSTRUCTION OF FAECAL SLUDGE TREATMENT PLANTS (FSTP) WORKS IN DAR ES SALAAM**	
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Wall details

Minimum area of reinforcement; k = **0.13** %

Cover to reinforcement in stem; c_{stem} = **30** mm

Cover to reinforcement in wall; c_{wall} = **30** mm

Factored horizontal at-rest forces on stem

Surcharge; $F_{s\_sur\_f} = g_{f\_l} \cdot K_0 \cdot \text{Surcharge} \cdot (h_{eff} - t_{base} - d_{ds})$ = **10.9** kN/m

Moist backfill above water table; $F_{s\_m\_a\_f} = 0.5 \cdot g_{f\_e} \cdot K_0 \cdot g_m \cdot (h_{eff} - t_{base} - d_{ds} - h_{sat})^2$ = **2** kN/m

Moist backfill below water table; $F_{s\_m\_b\_f} = g_{f\_e} \cdot K_0 \cdot g_m \cdot (h_{eff} - t_{base} - d_{ds} - h_{sat}) \cdot h_{sat}$ = **16.2** kN/m

Saturated backfill; $F_{s\_s\_f} = 0.5 \cdot g_{f\_e} \cdot K_0 \cdot (g_s - g_{water}) \cdot h_{sat}^2$ = **17.5** kN/m

Water; $F_{s\_water\_f} = 0.5 \cdot g_{f\_e} \cdot g_{water} \cdot h_{sat}^2$ = **27.5** kN/m

Calculate shear for stem design

Surcharge; $V_{s\_sur\_f} = 5 \cdot F_{s\_sur\_f} / 8$ = **6.8** kN/m

Moist backfill above water table; $V_{s\_m\_a\_f} = F_{s\_m\_a\_f} \cdot b_l \cdot ((5 \cdot L^2) - b_l^2) / (5 \cdot L^3)$ = **0.4** kN/m

Moist backfill below water table; $V_{s\_m\_b\_f} = F_{s\_m\_b\_f} \cdot (8 - (n^2 \cdot (4 - n))) / 8$ = **12** kN/m

Saturated backfill; $V_{s\_s\_f} = F_{s\_s\_f} \cdot (1 - (a_l^2 \cdot ((5 \cdot L) - a_l) / (20 \cdot L^3)))$ = **15.1** kN/m

Water; $V_{s\_water\_f} = F_{s\_water\_f} \cdot (1 - (a_l^2 \cdot ((5 \cdot L) - a_l) / (20 \cdot L^3)))$ = **23.7** kN/m

Total shear for stem design; $V_{stem} = V_{s\_sur\_f} + V_{s\_m\_a\_f} + V_{s\_m\_b\_f} + V_{s\_s\_f} + V_{s\_water\_f}$ = **58** kN/m

Calculate moment for stem design

Surcharge; $M_{s\_sur} = F_{s\_sur\_f} \cdot L / 8$ = **3.6** kNm/m

Moist backfill above water table; $M_{s\_m\_a} = F_{s\_m\_a\_f} \cdot b_l \cdot ((5 \cdot L^2) - (3 \cdot b_l^2)) / (15 \cdot L^2)$ = **0.3** kNm/m

Moist backfill below water table; $M_{s\_m\_b} = F_{s\_m\_b\_f} \cdot a_l \cdot (2 - n)^2 / 8$ = **6.1** kNm/m

Saturated backfill; $M_{s\_s} = F_{s\_s\_f} \cdot a_l \cdot ((3 \cdot a_l^2) - (15 \cdot a_l \cdot L) + (20 \cdot L^2)) / (60 \cdot L^2)$ = **6.1** kNm/m

Water; $M_{s\_water} = F_{s\_water\_f} \cdot a_l \cdot ((3 \cdot a_l^2) - (15 \cdot a_l \cdot L) + (20 \cdot L^2)) / (60 \cdot L^2)$ = **9.6** kNm/m

Total moment for stem design; $M_{stem} = M_{s\_sur} + M_{s\_m\_a} + M_{s\_m\_b} + M_{s\_s} + M_{s\_water}$ = **25.7** kNm/m

Calculate moment for wall design

Surcharge; $M_{w\_sur} = 9 \cdot F_{s\_sur\_f} \cdot L / 128$ = **2** kNm/m

SHANXI CONSTRUCTION ENGINEERING CORPORATION AND MINERAL COMPANY	**PROJECT:** **CONSTRUCTION OF FAECAL SLUDGE TREATMENT PLANTS (FSTP) WORKS IN DAR ES SALAAM**	
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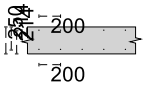
	CHECKED BY: G.N	**DATE:** Sept 2024

	Moist backfill above water table;	$M_{w\_m\_a} = F_{s\_m\_a\_f} \cdot 0.577 \cdot b_l \cdot [(b_l^3+5 \cdot a_l \cdot L^2)/(5 \cdot L^3)-$	
	$0.577^2/3] =$ **0.4** kNm/m		
	Moist backfill below water table;	$M_{w\_m\_b} = F_{s\_m\_b\_f} \cdot a_l \cdot [((8-n^2 \cdot (4-n))^2 /16)-4+n \cdot (4-n)]/8$	
	= **3.3** kNm/m		
	Saturated backfill;	$M_{w\_s} = F_{s\_s\_f} \cdot [a_l^2 \cdot x \cdot ((5 \cdot L)-a_l)/(20 \cdot L^3)-(x-b_l)^3 /(3 \cdot a_l^2)] =$	
	2.5 kNm/m		
	Water;	$M_{w\_water} = F_{s\_water\_f} \cdot [a_l^2 \cdot x \cdot ((5 \cdot L)-a_l)/(20 \cdot L^3)-(x-b_l)^3$	
	$/(3 \cdot a_l^2)] =$ **3.9** kNm/m		
	Total moment for wall design;	$M_{wall} = M_{w\_sur} + M_{w\_m\_a} + M_{w\_m\_b} + M_{w\_s} + M_{w\_water} =$	
	12 kNm/m		
			
	Check wall stem in bending		
	Width of wall stem;	b = **1000** mm/m	
	Depth of reinforcement;	$d_{stem} = t_{wall} – c_{stem} – (f_{stem} / 2)$ = **214.0** mm	
	Constant;	$K_{stem} = M_{stem} / (b \times d_{stem}^2 \times f_{cu})$ = **0.022**	
		Compression reinforcement is not required	
	Lever arm;	$z_{stem} = \min(0.5 + \sqrt{}(0.25 - (\min(K_{stem}, 0.225) /$	
	$0.9)),0.95) \times d_{stem}$		
		z_{stem} = **203** mm	
	Area of tension reinforcement required;	$A_{s\_stem\_des} = M_{stem} / (0.87 \times f_y \times z_{stem})$ = **315** mm^2/m	
	Minimum area of tension reinforcement;	$A_{s\_stem\_min} = k \times b \times t_{wall}$ = **325** mm^2/m	
	Area of tension reinforcement required;	$A_{s\_stem\_req} = \max(A_{s\_stem\_des}, A_{s\_stem\_min})$ = **325** mm^2/m	
	Reinforcement provided;	**12 mm dia.bars @ 200 mm centres**	
	Area of reinforcement provided;	$A_{s\_stem\_prov}$ = **565** mm^2/m	
		PASS - Reinforcement provided at the retaining wall stem is adequate	

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Check shear resistance at wall stem

Design shear stress; $v_{stem} = V_{stem} / (b \times d_{stem})$ = **0.271** N/mm²

Allowable shear stress; $v_{adm} = \min(0.8 \times \sqrt{(f_{cu} / 1\ N/mm^2)}, 5) \times 1\ N/mm^2$ = **4.000** N/mm²

PASS - Design shear stress is less than maximum shear stress

From BS8110:Part 1:1997 – Table 3.8

Design concrete shear stress; v_{c_stem} = **0.474** N/mm²

$v_{stem} < v_{c\_stem}$ - No shear reinforcement required

Check mid height of wall in bending

Depth of reinforcement; $d_{wall} = t_{wall} - c_{wall} - (f_{wall} / 2)$ = **214.0** mm

Constant; $K_{wall} = M_{wall} / (b \times d_{wall}^2 \times f_{cu})$ = **0.011**

Compression reinforcement is not required

Lever arm; $z_{wall} = \text{Min}(0.5 + \sqrt{(0.25 - (\min(K_{wall}, 0.225) / 0.9))}, 0.95) \times d_{wall}$

z_{wall} = **203** mm

Area of tension reinforcement required; $A_{s\_wall\_des} = M_{wall} / (0.87 \times f_y \times z_{wall})$ = **148** mm²/m

Minimum area of tension reinforcement; $A_{s\_wall\_min} = k \times b \times t_{wall}$ = **325** mm²/m

Area of tension reinforcement required; $A_{s\_wall\_req} = \text{Max}(A_{s\_wall\_des}, A_{s\_wall\_min})$ = **325** mm²/m

Reinforcement provided; **12 mm dia.bars @ 200 mm centres**

Area of reinforcement provided; $A_{s\_wall\_prov}$ = **565** mm²/m

PASS - Reinforcement provided to the retaining wall at mid height is adequate

Check retaining wall deflection

Basic span/effective depth ratio; $ratio_{bas}$ = **20**

Design service stress; $f_s = 2 \times f_y \times A_{s\_stem\_req} / (3 \times A_{s\_stem\_prov})$ = **176.2** N/mm²

Modification factor; $factor_{tens} = \min(0.55 + (477\ N/mm^2 - f_s)/(120 \times (0.9\ N/mm^2 + (M_{stem}/(b \times d_{stem}^2)))), 2)$ = **2.00**

Maximum span/effective depth ratio; $ratio_{max} = ratio_{bas} \times factor_{tens}$ = **40.00**

Actual span/effective depth ratio; $ratio_{act} = h_{stem} / d_{stem}$ = **11.68**

PASS - Span to depth ratio is acceptable

Indicative retaining wall reinforcement diagram

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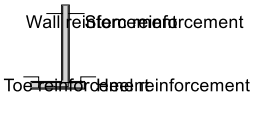

Toe bars - 12 mm dia.@ 200 mm centres - (565 mm^2/m)

Heel bars - 12 mm dia.@ 200 mm centres - (565 mm^2/m)

Wall bars - 12 mm dia.@ 200 mm centres - (565 mm^2/m)

Stem bars - 12 mm dia.@ 200 mm centres - (565 mm^2/m)

Appendix 5: Household Survey Report

THIS IS ISSUED AS A SEPARATE DOCUMENT THAT FORMS PART OF THIS REPORT

Appendix 6: Topographical Survey Report

THIS IS ISSUED AS A SEPARATE DOCUMENT THAT FORMS PART OF THIS REPORT