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KFW

LUSAKA WASTEWATER PROJECT

CONSULTANCY SERVICES FOR ENVIRONMENTAL AND SOCIAL IMPACT ASSESSMENT (ESIA)

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DRAFT FINAL ESIA REPORT

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TABLE OF CONTENT

LIST OF FIGURES

LIST OF TABLES

LIST OF ANNEXES

ATTACHED DOCUMENT

LIST OF ABBREVIATIONS

BOD	Biological Oxygen Demand
COD	Chemical Oxygen Demand
CBO	Community Based Organisation
CBD	Central Business District
CFU	Colony Forming Unit
CSO	Central Statistical Office
DS	Dry Substance Content
EIB	European Investment Bank
ESIA	Environmental and Social Impact Assessment
ESIS	Environmental and Social Impact Study
ESMP	Environmental and Social Management Plan
FC	Faecal Coliforms
FS	Feasibility Study
GRZ	Government of the Republic of Zambia
ha	Hectares
IAPs	Interested and Affected Parties
KfW	KfW Development Bank
LWSC	Lusaka Water and Sewerage Company
LWWP	Lusaka Waste Water Project
m	Meter
MPN	Most Probable Number
MoH	Ministry of Health
MinLGH	Ministry of Local Government and Housing
NGO	Non-Governmental Organisation
O&M	Operation and Maintenance
NPV	Net Present Value
PE	Population Equivalent
PFS	Pre-feasibility Study
PS	Pumping Station
SEP	Stakeholder Engagement Plan
TC	Total Coliforms

TL	Team Leader
TSS	Total Suspended Solids
(T)SS	(Total) Suspended Solids
WB	World Bank
WWTP	Wastewater Treatment Plant
ZEMA	Zambia Environmental Management Agency

0 NON-TECHNICAL SUMMARY

This Draft Final ESIA Report has been prepared as part of the Environmental and Social Impact Assessment (ESIA) process on selected wastewater treatment and transfer options of the Lusaka Waste Water Project (LWWP) on behalf of the Lusaka Water and Sewerage Company (LWSC) and the KfW Development Bank (KfW). The specific objective of this report aims to identify potentially negative and positive environmental and social impacts associated with the project implementation of the selected option – here Option 5 - and to mitigate any potential negative impacts and monitor the related aspects.

Background

Urban growth in Lusaka has resulted in increased wastewater generation. However, disposal and treatment systems were not implemented in order to meet the demand and overall investments into sanitation infrastructure have not been sufficient over the last decades.

In order to cope with this situation the Lusaka Water and Sewerage Company (LWSC) in cooperation with international donors and other stakeholders has embarked the Lusaka Waste Water Project (LWWP). Under this project significant investments to improve Lusaka's wastewater infrastructure are planned. This includes the upgrade and/or construction of wastewater treatment plants, the upgraging of six pumping stations and the extension of the sewer network by 520 km.

For this purpose four (4) relevant main options on wastewater treatment plants, sub-divided into seven (7) project variants – referred to as Options 1 - 4 (A-C) - were investigated. This option analyses executed by the EIB Feasibility Study Consultant was referring to the identification of the most appropriate solution with view to technical, operational and economic conditions. Along with this study, environmental and social relevant aspects were investigated and presented in the Draft ESIA Report submitted to LWSC and KfW.

As preliminary result Option 4B had been recommended for implementation. Subsequently, it was decided amongst the involved stakeholders to analyse one more option, **Option 5, which was finally accepted as the preferred option in May 2016.**

In this context the Draft Final ESIA Report shall serve:

a) To provide information on environmental and social impacts associated with the selected ('preferred') option, here Option 5;

b) To integrate mitigation measures in the technical planning process of the Feasibility Study (funded by EIB) and later Design Phase,

c) To facilitate decision-making on funding by involved donors.

Current Wastewater Infrastructure and Associated Environmental and Social Impacts

Manchinchi WWTP: The Manchinchi WWTP is located in Ngwerere Ward near the center of Lusaka and is covering an area of around 28 ha. It is surrounded by the three high density residential areas of Chilulu, Garden and Luangwa compounds, and a relatively low density residential area, namely Northmead.

The WWTP has a design capacity of 36,000 m^3/d, however the plant is hydraulically overloaded. Additional to the inflowing wastewater, a significant volume of domestic/industrial wastewater and faecal sludge from pit latrines is supplied by tankers.

Today Manchinchi WWTP is more or less un-operational. Presently, most part of the WWTP is bypassed, and wastewater is directed to the maturation ponds at Garden ponds.

The following key observations indicating current pressing issues have been made:

- Reception station for faecal sludge is poorly managed, thus generating smell and attracting vectors (mosquitos);
- The surrounding wall around the WWTP area is partly destroyed; open space is used for disposal of solid waste, posing a health threat;
- Residents regularly cross the WWTP area despite the presence of safeguard personnel;
- Residential areas in main wind direction (East-West) are directly affected by foul gases;
- Solid waste resulting from wastewater treatment process has accumulated over time and 'invites' neighbors to dispose off their domestic solid waste;
- Residents and their representatives do not perceive any benefit from the WWTP for the community, but consider it as an annoying, undesired installation; and
- Community leaders perceive the unused space in the WWTP compound as a waste of land and requested LWSC already to hand it over to the community for residential constructions.

Garden Ponds: Linked to the Manchinchi WWTP are the Garden Sewage Ponds. These ponds are located within Garden compound but about 1 km further north of the Manchinchi WWTP and are the final purification facilities for the treated effluent from the Manchinchi WWTP. The total area is about 44 hectares.

Designed as maturation ponds to disinfect the treated effluent from Manchinchi WWTP the system is consisting of 8 ponds operated as 2 line system with 4 individual ponds each with a gravity based flow regime. The total volume of the ponds is expected in the interval 250,000-300,000 m^3 however all ponds are more or less filled with settled sludge. Today, the ponds are in poor condition, both in terms of its physical structure but also representing a massive risk to the population and the environment.

At Garden Ponds, the following observations on current pressing issues potential have been made:

- Around the area the protective fence is completely missing.

- Massive smell covers the surrounding residential area due to the generation of fouling gases.
- Effluent more or less stagnant with massive attraction of vectors.
- Local population is using the pathways between the ponds to reach the main road.
- LWSC maintenance staff fully exposed to unsafe working conditions and related health risks.
- Flowerpot producers around the ponds fetch water to irrigate their plants for sale.

Chunga WWTP: Chunga WWTP is located in the Mwambeshi Ward and is covering an area of 14 ha. Two main types of land uses are distinguished: residential developments (dwellings) and a grave yard. New residential properties are being developed around the Chunga WWTP.

The WWTP, designed as trickling filter technology has a capacity of 9,100 m^3/d, but is hydraulically overloaded. The WWTP is receiving a mix of industrial and domestic wastewater. Technologically, the WWTP is more or less un-operational. Presently, poorly treated wastewater is directed into the Chunga River.

The following observations on current pressing issues and conflict potential have been made:

- Chunga WWTP suffers from the complete lack of a boundary fence, thus there is no security.
- Some manholes in the WWTP are not covered, and wastewater streams are flowing fast in about 3m depths towards Chunga stream.
- Chunga River is a solid waste loaded water body, which carries solid waste from a number of residential areas upstream. Like in Manchinchi community, the overall environmental sanitation conditions of Chunga community demands for immediate action and community education strategies.
- Across Chunga River and facing Chunga WWTP a new residential area (obviously middle to higher-middle income) starts to grow. Odor caused by the treatment system could impact the future residents.

Ngwerere Ponds: The Ngwerere sewage ponds are located in Kapwayambale Ward in rural areas about 12 km northeast of Lusaka city. The total area is about 24 hectares. A high density residential area, Silvia Masebo Compound, is located to the immediate north and east of the secondary ponds. The high density residential area has been formalized in the year 2008.

The Ngwerere sewage ponds were designed as maturation ponds to disinfect the sewage effluent from the residential settlements of Kabanana, parts of Mandevu, Emmasdale as well as parts of Rhodes Park. The pond system consists of 4 ponds, thereof 2 primary and 2 secondary ponds and is in the ownership of LWSC. From the operational point of view the system looks well maintained.

The exact water depth is not known, but is estimated at 1-1.5 m, i.e. total volume is some 170,000 m^3.

The following observations on current pressing issues and conflict potential have been made:

- The access road to the ponds is a narrow, unpaved road directly bordering to the compound.
- Physical security and public health issues: no fence and no barriers are in place around the ponds pose a high risk for drowning incidents for both children and adults. It further enables open access for everybody to use the partly treated water for illegal and unsafe irrigation.
- Digging of shallow wells for 'drinking water supply' in the community is associated with potential infiltration of unsafe waters from the ponds, but the deeper boreholes equipped with hand pumps are blocked by silt.
- Availability of Land for WWTP extension: Today only the area around the ponds is owned by LWSC. Respectively, due to limited space in the ownership of the LWSC future extension areas are to be acquired from private owners.
- Sludge and Effluent Reuse: The small farms surrounding the ponds are irrigated with water from the ponds. This practice is forbidden, however no effective control mechanisms are established.

Infrastructure Components of Option 5

Under Option 5, a wastewater treatment structure with two WWTPs – New Ngwerere and New Chunga WWTPs will be considered. Manchinchi WWTP including the Garden ponds are proposed to be decommissioned and the areas to be sold.

Ngwerere site: The new treatment concept is based on trickling filters; anaerobic digestion of sludge and potential biogas utilisation will be considered. Hereby, the existing Ngwerere pond system will be replaced. Considering the 2025 loads the new treatment system will be implemented within the existing 24 ha site currently in the ownership of the LWSC. In the year 2040 a moderate extension of the area by ~ 10 ha is envisaged.

Chunga WWTP: From the technological point of view the new treatment concept is also based on trickling filters; anaerobic digestion of sludge and potential biogas utilisation. The new treatment system will be implemented within the existing 14 ha site in the ownership of the LWSC. In the year 2040 no extention of the area is required.

Manchinchi WWTP: Altogether, the current area of Manchinchi WWTP is 28 hectares. Following the technical concept of the EIB FS Consultant the site will be divided into three sections, a southern portion, a central portion and a northern portion. The central section, today covered by the faecal acceptance station will continue operation by receiving septage from the cesspool tankers. This section is covering an area of 2.3 hectares; respectively 26 hectares are proposed to be sold. For this purpose the following activities are proposed:

- Demolition of structures and buildings;
- Transport and disposal of construction waste at Chunga landfill; and
- Levelling of land.

Sale of the excess areas is proposed after completion of the project and is expected to take place over a period from 2019 to 2025.

Garden Ponds: Along with the Manchinchi WWTP the Garden ponds consisting of 8 ponds operated as 2 line system with 4 individual ponds each with a gravity based flow regime. The total area is covering 44 hectares.

Decommissioning of Garden ponds includes:

- Construction of boundary wall to avoid further encroachment;
- Emptying, collection, transport and reuse of sludge in agriculture; and
- Levelling of land.

Wastewater transfer: Wastewater generated in the Manchinchi catchment, but also wastewater generated in the Ngwerere catchment is proposed to be conveyed to the new Ngwerere WWTP for treatment. The flow will be by gravity along the existing CSU-07 pipeline route which is approximately 10,400 meters long.

Positive and Negative Impacts

There is potential for negative and positive impacts from the proposed implementation of Option 5. Most of the negative impacts which might occur during construction and operation can be reduced or eliminated by mitigation.

- Most of the potential negative impacts are confined to the demolition and/or construction phases. Direct impacts from construction on the physical and socio-economic environment including health and safety and environmental issues can be reduced or eliminated, principally by measures taken by the works contractors in compliance with the proposed Environmental and Social Management Plan, IFC Performance Standards, existing Zambian laws and regulations and FIDIC standard contract provisions.
- The major benefit of the project will be during the operational phase from improved access and reliability of waterwater treatment services in the urban Manchinchi center as well as the peri-urban areas of Chunga and Ngwerere. The decommissioning of the Garden Ponds and Manchinchi WWTP will significantly decrease the incidence of water-borne diseases, eliminate smell, noise and solid waste accumulation.

  With reference to the wastewater transfer pipeline from Manchinchi WWTP to Ngwerere site the implementation of the new pipeline in correct dimension is likely to reduce blockages and overflows, hereby eliminating or reducing a variety of health and safety issues.

Advantages and Disadvantages of Option 5 Implementation

The implementation of Option 5 will be associated with advantages and disadvantages in regard to all concerned sites. Hereto the following Table 0-1 is providing an overall assessment with reference to general (primarily technical), environmental and social aspects.

Table 0-1: Summary assessment of wastewater treatment Option 5

Advantages	Disadvantages
General	
In addition to Chunga and Manchinchi, this Option also treats the wastewater from the Ngwerere catchment.	All WWTPs: Intensive safeguard measures to be implemented as WWTP demolition and/or construction and operation takes place in densely populated environment (noise, smell, visual impacts etc.)
All disposal of sludge to be catered for outside city centre.	Potential transfer of significant (waste-)water volumes from Manchinchi to Ngwerere catchment. Transfers will impact the water balances, but also customary water rights.
Same wastewater technology as previously applied on Chunga and Manchinchi WWTPs, which is known to LWSC. Introduction of chlorination to reduce area requirements.	
Chosen wastewater treatment technology provides gas utilisation from sludge treatment with the possibility of future extensions into electricity production.	
Closure of Manchinchi WWTP and Garden Ponds	
Closure of Manchinchi WWTP* and Garden Ponds will have an important environmental and health impact for people living in vicinity of the sites.	Decommissioning/de-sludging of the Garden Ponds will cause higher levels of disturbance (noise, smell), but will be limited to a short period.
Creation of job opportunities, especially for unskilled workers during the demolition/de-sludging phases.	
Significant wastewater volumes treated outside of the urban city center with positive impacts on health and security conditions for residents esp. neighbouring Manchinchi WWTP.	
New Chunga WWTP	
During the dry season effluent discharge in the receiving water (Chunga River) will have significant dilution effects. Effluent flow will benefit to the down-stream communities.	Risk of heavy metal contamination of the sludge, in case Trade Effluent Standards are not fully enforced (like at present)
WWTP can be accommodated within the existing sites; no additional land acquisition required.	High risk to public health, if sludge is used in agricul-ture. This behaviour cannot be excluded, because the WWTP is surrounded by agricultural land and small holders, some of them already collect sludge for its reuse as soil improver, although this practise is illegal.
No (involuntary) resettlement is required.	Fast growing residential settlement bordering to the WWTP site requires intensive environmental and social safeguard measures during all project phases (demoli-tion / re-construction / operation).
Creation of job opportunities for skilled and unskilled workers during all project phases (demolition / con-struction / operation) as well as economic and social development.	Community graveyard located along the access road to the WWTP site to be protected against short term impacts (demolition / reconstruction works) and long terms affects (visibility of WWTP structures).

Advantages	Disadvantages
No (waste-)water transfers to other catchments.	
New Ngwerere WWTP / Silvia Masebo Compound	
Potential safe reuse of treated wastewater for ferti-irrigation purposes by local farmers.	During dry season receiving water has no flow up-stream of effluent, i.e. no dilution will take place.
Year 2025: WWTP can be accommodated within the existing site.	It is a risk that smell, noise, increased traffic and solid waste will create neighbourhood conflicts
Creation of job opportunities for skilled and unskilled workers during all project phases (demolition / con-struction / operation) as well as economic and social development.	Up to the year 2025: Construction/broadening of the road and traffic during construction will require moving of about 20-30 households; farmers in Silvia Masebo Compound will have to abandon their vegetable fields in direct vicinity to the WWTP - at least during construction period.
	Year 2040: WWTP extension requires moderate additional land acquisition of about 10 ha. This process can be associated with the potential resettlement of up to 20 households.
	Potential risk of flooding due to unsufficient capacity of the receiving tributary of the Ngwerere River not investigated yet.
Wastewater transfer pipeline from Manchinchi WWTP to Ngwerere site	
Construction of new pipeline in correct dimension (replacement of existing DN 300/600 sections by DN 900) likely to reduce blockages and overflows.	Some sections are in close proximity to existing residential houses (CSU-07, between M 132 - M 118) or houses are directly built on the proposed pipeline course (between M 107 - M 101; M 97 - M 76). Re-routing of the pipeline has to be considered to avoid resettlement and compensation.
Creation of job opportunities, especially for unskilled workers during the construction phase.	Massive disturbance of residents, public roads and traffic flows during construction phase is likely.

* - 2.3 ha remaining for faecal sludge acceptance and transfer station

Outline of Resettlement Policy Framework (Requirement of Resettlement Action Plan Preparation)

The purpose of the specific RPF outline is to provide a guide to addressing land acquisition and resettlement issues in the area of Ngwerere ponds as one considerable impact of the project. The justification for the individual projects being proposed under Option 5 are stated as follows:

- Ngwerere: Re-construction, paving and broadening of the existing access road.

  The implementation of Option 5 will require the **relocation of about 20 to 30 households along the access road** and the change of land use from agriculture to WWTP purposes. Formal land acquisition has to be prepared and carried out as Silvia Masebo Compound has been formalized as residential area in 2008, and the residents are in the process to obtain their documentation as owners of their plots. World Bank policy on Involuntary Resettlement (OP 4.12) is therefore triggered.

- Ngwerere: In the reference year 2040 the extension of 10 ha (total area in the year 2040: ~ 34 ha) of the WWTP area is required, therefore **resettlement and /or compensation for agricultural soil, and about 20 households could then be required.**
- Chunga: Treatment concept based on trickling filters and anaerobic sludge treatment; entire site of 14 ha owned by LWSC will be included in the concept and protected against neighbors, who (illegally) used the terrain for agricultural activities. **Nonetheless, no resettlement activities are required.**
- Wastewater transfer pipeline from Manchinchi site to Ngwerere site: The investigation of all sections has revealed that there is no requirement for resettlement, except the section crossing Mazyopa Compound (section from manholes M 98 – M 75). However, as proposed by the EIB FS Consultant crossing this section can be avoided by re-routing this pipeline section. **Respectively, applying this measure will avoid the necessity of a Resettlement Action Plan.**

The principle behind the RPF outline incorporates planning of project activities so as to minimize and/or mitigate resettlement impacts. The herewith presented RPF outline provides for the mitigation of potential resettlement impacts; it allows for the later formulation of subproject specific resettlement screening and Resettlement Action Plans (RAPs), which have to be elaborated in a next phase.

Due to its importance the RPF outline is presented as **corresponding attachment** to this Draft Final ESIA study.

Recommendations and Requirement of Additional Studies

The ESIA has identified the following issues with recommendations for follow-up action.

- Sludge Management Plan: During the next years with the increased implementation of wastewater treatment capacity significant volumes of sewage sludge will be generated and need to be reused or safely disposed.
- Agricultural Areas and Corresponding Crop Structure: Corresponding to the requirements of a Sludge Management Plan, potential agricultural areas need to be identified.
- Solid Waste Disposal Facilities: The future WWTP operation will also generate significant volumes of solid waste. This includes common municipal type solid waste, but also grit and screening material. Here temporary storage at the WWTP area might be applicable, finally all these types of waste need to be safely disposed.
- Groundwater Quality Investigation and Assessment: Currently, no qualitative and quantitative groundwater baseline data around the WWTP sites are available. Existing data are from boreholes in the wider catchment and only collected sporadically.
- Water Transfer among Catchments and Associated Water Rigths: Currently only a ‘snap shot’ investigation describing the dry weather flows of the concerned receiving waters and roughly estimated catchment transfers are available. Both gaps should be subject of in-depth investigations allowing the detailed characterisation of the concerned catchments and associated customary water rigths.
- Capacity of the Receiving Waters: So far, dry season capacity measurements (upstream – WWTP outlet – downstream) of the Chunga River and the tributary of the Ngwerere River are available. Accepting the higher volumes of generated effluent in future especially during the

rainy season and (waste-)water catchment transfers to the Ngwerere site might be associated with the risk of floodings due to the unsufficient capacity of the receiving waters.

- Right of Way along the WWTP Transfer Pipeline: All findings presented so far have been prepared without an in-depth investigation of the rigth of way.

Further Proceedings

Effluent standards: During the early project phase the EIB FS Consultant had organised initial consultations with ZEMA seeking clarification on applicable effluent design criteria. Key objective of the consultation was the clarification of individual effluent parameter as outlined in the Environmental Management Regulations SI 112 of 2013 and its applicability to the project.

In this context the following effluent parameters have been discussed: BOD / COD (ratio), nitrogen (here total nitrogen, ammonia, ammonium), phosphorus and the microbiological parameter Escherichia coli, faecal coli, total coliforms).

Arguing that the application and achievement of the effluent criteria in question is requiring a more sophisticated technological approach what would be connected with an higher area demand and/or higher costs, the EIB FS consultant has been proposed the application of the relevant EU Standard (Urban Wastewater Treatment Directive, 91/271/EEC) or in case of the microbiological effluent parameters faecal and total coliforms instead of the parameter Escherichia coli.

During a consultation meeting of all important stakeholders (LWSC, KfW, EIB and ZEMA) held June 29, 2016, ZEMA stated that the FS study undertaken by the EIB FS Consultant established that the technology to be used in the constructed WWTP would **not** attain the quality of the treated effluent as provided for by the Environmental Management Regulations SI 112 of 2013 as they were very strict.

In response to this situation the following parameters have been waived and are still subject of agreement between the involved stakeholders:

- E-coli criteria > by faecal / total coliforms;
- COD/BOD ratio.

Requirement for ESIAs in accordance with the Zambian ESIA standard: Early consultations with ZEMA have revealed the fact that subsequent ESIA studies in accordance with the relevant Zambian ESIA standard are to be prepared. With letter dated August 08, 2016 (made available to the EIA Consultant August 23, 2016) ZEMA has requested separate ESIA studies to the following sub-project and/or locations:

- Rehabilitation and upgrading of Chunga WWTP,
- Upgrade of Ngwerere waste stabilization ponds to a biological trickling filter WWTP,
- Sewer network (here wastewater transfer pilpeline) from Manchinchi WWTP to Ngwerere site (along pipeline CSU-7),

- Decommissioning of Manchinchi WWTP and associated Garden ponds,
- Upgrade of sewage pumping stations and main collectors, and
- Expansion of sewer network (by 520 km).

1 INTRODUCTION

1.1 Background

Due to a tremendous growth of population, high immigration rates and socio-economic conflicts, Lusaka nowadays is facing serious environmental and social problems. The actual population is not clearly determined. While the census for 2000 showed a total population in Lusaka of 1.39 million residents, the 2010 census indicates a growth to 2.2 million which can be understood as a consequence of high birth rates and ongoing immigration.

Urban growth in Lusaka has resulted in increased wastewater generation. However, disposal and treatment systems were not implemented in order to meet the demand and overall investments into sanitation infrastructure have not been sufficient over the last decades.

It is estimated that currently only 10-15% of the residents of Lusaka are connected to the sewer network, 40-45% use septic tanks while about 43% have pit latrines that are in a poor condition. According to **Lusaka Water and Sewerage Company (LWSC)**, in peri-urban areas of Lusaka about 90% of the residents have no access to adequate sanitation facilities and the use of pit latrines is very common. This presents a significant health threat, especially in areas with a high water table, where groundwater is likely to be contaminated during the rainy season. As residents use water from the ground for domestic purposes and for consumption, water borne diseases spread easily.

1.2 Objectives of the Lusaka Waste Water Project (LWWP)

In order to cope with this situation the Lusaka Water and Sewerage Company (LWSC) in cooperation with international donors and other stakeholders has embarked the **Lusaka Waste Water Project (LWWP).** Under this project significant investments to improve Lusaka's wastewater infrastructure are planned.

When the LWWP was conceptualized, LWSC approached several Development Finance Institutions (DFIs) for funding. After several discussions with the LWSC, the World Bank (WB), the African Development Bank (AfDB), the European Investment Bank (EIB) and **KfW Development Bank** agreed to consider the Project for funding.

The LWWP aims to determine and implement required measures for the improvement of existing wastewater treatment facilities as well as the sewer network and to specify associated investment needs.

It contains the upgrading and extension of the existing wastewater system as follows:

1. **Rehabilitation and upgrading of the Manchinchi and Chunga Wastewater Treatment Plants or implementation of a new, centralized Wastewater Treatment Plant at Ngwerere Ponds.**

2. **Upgrading of 6 Pumping Stations.**

3. **Extension of the sewer network by 520 km; thereof 20 km upgrading of interceptors.**

Hereto, the LWWP will be structured into two phases. Phase I will consist of the rehabilitation and upgrading of wastewater facilities (Activity 1), main collectors and pumping stations (Activity 2) and will potentially be financed by KfW and EIB.

Phase II will address the expansion of the associated sanitation and sewerage network (Activity 3) and will potentially be financed by WB and AfDB.

In this context KfW was asked to undertake preparatory studies for the implementation of Phase I and has agreed to finance a Financial and Tariff Study (Study 1) and an **Environmental and Social Impact Assessment (Study 2).**

The next Figure 1-1 is providing an overview of the LWWP.

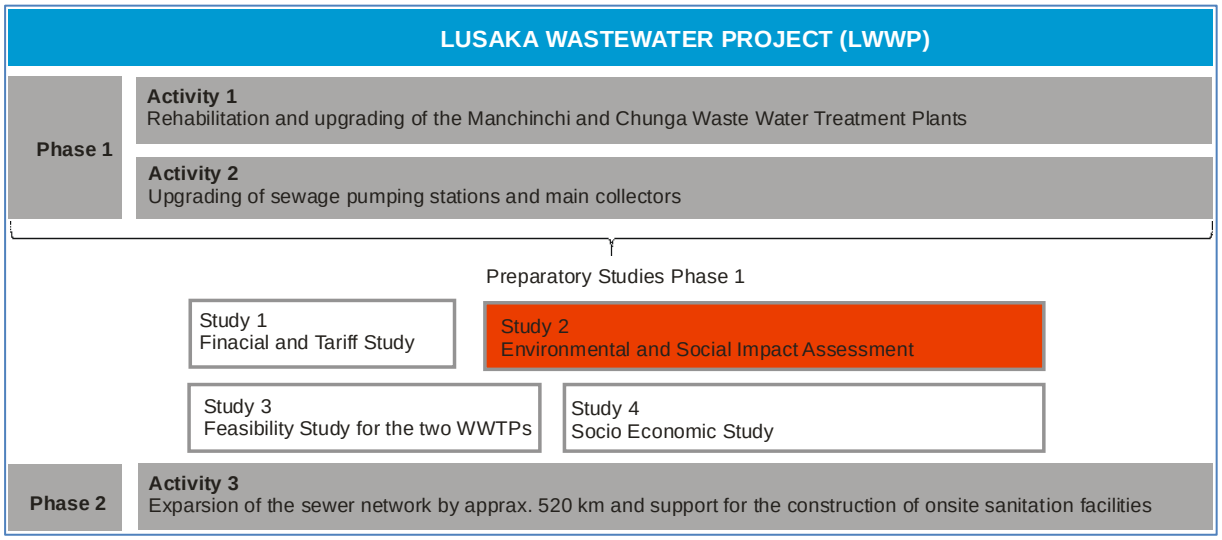


Figure 1-1: Lusaka Waste Water Project

1.3 Objectives of the ESIA

Respecting the fact that the rehabilitation of wastewater treatment facilities is highly sensitive to social and environmental issues, the project is considered to be a **Category A** project according to KfW's requirements. This requires an in-depth appraisal of the environmental and social constraints. In order to address potential impacts associated with the intended improvement of the wastewater infrastructure and facilities an **Environmental and Social Impact Assessment Study (ESIA)** will be undertaken. The ESIA aims to identify potentially negative and positive environmental and social impacts of the project implementation and to finally lead to an Environmental and Social Management Plan (ESMP) to mitigate any potential negative impacts and monitor the related aspects.

Hereby, the ESIA primarily follows to achieve objectives as agreed with the KfW and other international standards as introduced by potential funding agencies.

The ESIA study funded by KfW serves:

d) To provide information on environmental and social impacts associated with potential options (including some sub-options) and selection of the preferred option;

e) To integrate mitigation measures in the technical planning process of the Feasibility Study (funded by EIB) and later Design Phase, and

f) To facilitate decision-making on funding by involved donors.

1.4 Involvement of the Zambian Environmental Management Authority (ZEMA)

Initial consultations with ZEMA held June 23, 2015 revealed the fact that their full involvement is requiring the identification of a preferred project option (which is usually decided upon after the Feasibility Study Stage). As in many other countries, ESIAs according to national laws are being requested during the design stage. Complying with this situation it is considered that a subsequent, individual ESIA study shall be undertaken in accordance with the Zambian regulations (ZEMA standards).

In this context, being at an early planning stage of the project without a clearly identified project option, the present study can only follow international and national ESIA standards up to a certain point.

Nontheless the initial unofficial role of ZEMA it was agreed that all process-related documents (Scoping Report, ESIA Reports, Stakeholder Engagement Plan etc.) will be made available. Resulting comments are to be respected and integrated. Also, it was agreed that ZEMA representatives will be invited to all relevant meetings and public consultations such as the Scoping meeting(s) and community meetings.

Having agreed Option 5 amongst the LWSC, EIB and KfW as preferred option an official consultation meeting was scheduled June 29, 2016 in order to discuss the type and content of the subsequent ESIA to be performed in accordance with the Zambian ESIA standard. As also other issues of importance have been addressed during the consultations with ZEMA reference is made to Chapter 9 ‘Further Proceedings’.

1.5 Scope of the ESIA Report

The initial purpose of the (Draft) ESIA report has been summarising and complete the information required for the project appraisal and should be compiled in accordance with KfW's requirements

for the appraisal of infrastructure projects. For this purpose the (Draft) ESIA report was focused on the Options 1 – 4C, hereby covering the following aspects:

- Introduction
- Legislative and Institutional Framework
    - requirements under Zambian laws and regulations, applicable international treaties and agreements
- Description of the Project
    - project locations of wastewater facilities
    - description of its current technological conditions
- Project Alternatives
    - consideration of feasible technical preferable alternatives
    - findings and outcomes of the option analysis investment on wastewater facilities
- Outcomes of the Scoping
- Description of the Social, Environment, and Public Health Status Quo
    - baseline environmental and social conditions
- Impact Identification and Analysis including Cumulative Impacts
    - impacts on environmental key receptors
    - socio-economic impacts
    - impacts on affected communities, and disadvantaged or vulnerable groups
    - gender and disproportionate gender impacts
    - land acquisition and involuntary resettlement
- Mitigation Measures
- Environmental and Social Management Plan and Monitoring
- Public Involvement and Participation
    - consultation and participation of affected parties in the design, review and implementation of the Project

After submission of the Draft ESIA report in November 2015 it was decided among the LWSC, EIB and KfW to investigate one more option. Having identified Option 5 as the preferred option the proposed Draft Final ESIA report has been constricted exclusively focusing on this option. For this purpose the document structure has been slightly modified.

2 LEGISLATIVE AND INSTITUIONAL FRAMEWORK

This section addresses the legislative and institutional framework relating to ESIA. For this project the ESIA has been prepared in compliance with the:

- Sustainability Guidelines of KfW Development Bank,
- World Bank OP 4.01 (general framework) and OP 4.12 (involuntary resettlement),
- Environmental and Social Practices and Standards of the European Investment Bank (EIB),
- General EHS Guidelines of the World Bank Group, and
- Core labour standards of the International Labour Organisation (ILO).

National framework considers environmental law and regulations of the Government of the Republic of Zambia (GRZ), in particular, the Environmental Management Act No.12 of 2011 and in accordance with the requirements of the Environmental Impact Assessment (EIA) Regulations, Statutory Instrument No.28 of 1997.

However, as briefly introduced previously, given by the specific objectives of the ESIA study, the national legal and institutional framework is only followed to a certain extent. This specifically refers to regulations, standards and procedures as imposed by ZEMA.

As for convenience purposes the relevant national and international legislative and regulatory framework is introduced hereafter. While a comprehensive elaboration of the complete national legislative and regulatory framework is assembled as **Annexes 1 to 3.**

2.1 Donor Safeguard Policies and Strategies

2.1.1 KfW Sustainability Guideline

Internationally, the KfW Sustainability Guideline (latest update April 2014) set high standards which oblige all those involved to act in a sustainable fashion. This guideline implies consistency with international environmental, social, health, safety and labour standards.

In terms of the public participation the guideline stipulates: An important element of the ESIA planning and decision-making process is to involve the communities concerned and keep the public informed.

Moreover, it is crucial to use appropriate media channels to provide the affected communities and, as the case may be, the general public with comprehensive information in all phases of the project; such information will be provided by LWSC Public Relation office in a timely and culturally suitable manner. Interested parties in a climate change assessment (e.g. those affected, the public) should also be involved in relevant cases.

Public participation has been done by conduction of the scoping workshop in the LWSC premises as well as by several community meetings in the scope of the socio-economic survey.

2.1.2 EIB Environmental and Social Practices Handbook

The EIB Environmental and Social Practices Handbook describe the processes and practices of the Bank to ensure that all financing activities are consistent with its environmental policy. EIB applies a broad definition of the term 'environment', including protection of the natural environment and improvement of the built environment. It also recognises the need to consider a number of related social issues with the aim of achieving an integrated environmental and social assessment. In the following central environmental and social requirements are highlighted.

Topic A 4.2 - environmental consideration of projects:

- The EIB requires that all projects (irrespective of location) likely to have a significant effect on the environment be subject to an EIA, according to the definitions and requirements of Directive 97/11/EC and 2003/35/EC. Annex I of the Directive lists the types of project for which an EIA is mandatory and Annex II the types of project for which the need to carry out an EIA is decided by the Competent Authorities. The EIA, which includes public consultation, is the responsibility of the Promoter and the Competent Authorities. It should be completed and its findings and recommendations should satisfy the requirements of the Bank prior to disbursement.

Topic B1.1 (No. 67 and 74) - environmental and social assessment general background

- (67) All Bank projects are assessed for their expected impacts in terms of greenhouse gas emissions; the scope for improvements in energy efficiency and the need for measures to adapt to climate change are also reviewed.
- (74) All projects outside the EU are assessed against the **social safeguards** of the Bank, which are defined in a number of guidelines covering the following topics: population movement, including involuntary resettlement, the core labor standards of the International Labor Organisation (ILO), gender issues, occupational and community health and safety, and consultation and public participation (…).

2.1.3 World Bank Policies

Last revised in April 2013 the World Bank policies OB/BP 4.01 provides a general framework aiming to ensure the environmental and social soundness and sustainability of investment projects. The policy supports the integration of environmental and social aspects of projects in the decision-making process.

While OP/BP 4.12 is specifically addressing involuntary resettlement. Consideration of this policy is to avoid or minimize involuntary resettlement and, where this is not feasible, assist displaced persons in improving or at least restoring their livelihoods and standards of living in real terms relative to pre-displacement levels or to levels prevailing prior to the beginning of project implementation, whichever is higher.

2.2 Core Labour Standards (CLS) of the International Labour Organisation

The International Labour Organisation (ILO) is a tripartite organisation consisting of trade unions, governments and companies, and is part of the United Nations system. In 1998, the ILO produced the Declaration on Fundamental Principles and Rights at Work. In the Declaration, ILO member states agreed that they should all respect, promote, and realise **Core Labour Standards** (whether or not they have ratified them).

The core labour standards consist of four standards, laid out in eight conventions:

- Freedom of association and the effective recognition of the right to collective bargaining (Convention No. 87 & No. 98).
- The elimination of all forms of forced and compulsory labour (Convention No. 29 & No. 105).
- The effective abolition of child labour (Convention No. 138 & No. 182).
- The elimination of discrimination in respect of employment and occupation (Convention No. 100 & No. 111).

Today all International Financing Institutions including the EIB have fully adopted CLS in their activities. In this context reference is made to 'The EIB Statement of Environmental and Social Principles and Standards' published in the year 2009.

2.3 Relevant National Legislative and Regulatory Framework

The legislative and regulatory framework governing ESIA development in the Zambian water and sanitation sector stretches across various institutions. The main ones are the Ministry of Tourism, Environment and Natural Resources through the Zambia Environmental Management Agency (ZEMA), The Ministry of Health through the Public Health Department and the Ministry of Local Government and Housing through the various local authorities. Furthermore, the National Water and Sanitation Council (NWASCO) also regulated the various water utilities responsible for providing water and sewerage services across the country.

Table 2-1 summarizes the regulatory mandate of various actors and indicates their roles and responsibilities in ESIA development in the in Zambian water and sanitation sector.

Table 2-1: Summary of regulatory mandate, roles and responsibilities related to ESIA studies in the water and sanitation sector

Stakeholder / Organisation	Reference of legislation that defines roles	Relevant current roles and responsibilities related to ESIA
Ministry of Tourism, Environment and Natural Resources (MTENR)	National Env. Action Plan (NEAP) of 2014 National Policy on theEnvironment (NPE) of 2010 Constitution of the Republic of Zambia	- Environmental policy development. - Environment and natural resource management. - Raising public awareness on env. Issues. - Strategy development related to env. Improvements. - Effect international policy and principles on the environm.

Stakeholder / Organisation	Reference of legislation that defines roles	Relevant current roles and responsibilities related to ESIA
Zambia Environmental Management Agency (ZEMA)	Environmental Man. Act No 12 of 2011 Environmental Man. (Licensing) Regulation Statutory Instrument No. 28 of 1997 ESIA Regulation	- Monitoring and enforcement of environmental regulations. - Execution and monitoring of ESIA procedures. - Licensing of generation, transportation, storage and disposal of wastewater. - Coordinating & advisory roles related to env. man. - Raising public awareness on environment.
National Water Supply and Sanitation Council (NWASCO)	Water Supply & Sanitation Act, No 28 of 1997	- Water supply and sanitation services. - Monitoring water quality.
City, Municipal and District Councils	Local Government Act, Cap 281 Town and Country Planning Act, Cap 283 EMA of 2011	- Development plans for the area under their responsibility. - Wastewater treatment, incl. identification WWTP develop. - Setting tariffs and applicable by-laws.
Ministry of Local Government and Housing (MLGH)	Local Government Act, Cap 281 Town and Country Planning Act, Cap 283	- Local government policy development. - Oversight and advisory role to Councils. - Approval of development plans. - Payment of grants to Councils.

All the government bodies listed above enforce individual pieces of legislation as they pertain to environmental safeguards in the water and wastewater sector. The main ones include the:

- National Policy on Environment / National Environmental Action Plan (NEAP) of 1994
- Environmental Management Act of 2011;
- Statutory Instrument (SI) No.28 under the Environmental Protection and Pollution Control (ESIA) Regulations of 1997
- Water Supply and Sanitation Act of 1997
- The Town and Country Planning Act.

In the following the regulations mentioned before and the main institutional bodies are introduced in more detail hereafter.

2.3.1 National Policy on Environment

The National Policy on Environment (NPE) is the principal policy that coordinates environmental management in Zambia. The NPE is designed to create a comprehensive framework for effective natural resource utilization and environmental conservation which will be sensitive to the demands of sustainable development. The specific objectives of the NPE are to:

- promote the sound protection and management of Zambia's environment and natural resources in their entirety, balancing the needs for social and economic development and environmental integrity to the maximum extent possible, while keeping adverse activities to the minimum;

- manage the environment by linking together the activities, interests and perspectives of all groups, including the people, nongovernmental organizations (NGOs) and government at both the central and decentralized local levels;
- accelerate environmentally and economically sustainable growth in order to improve the health, sustainable livelihoods, income and living conditions of the poor majority with greater equity and self-reliance;
- ensure broadly-based environmental awareness and commitment to enforce environmental laws and to the promotion of environmental accountability;
- build individual and institutional capacity to sustain the environment;
- regulate and enforce environmental laws; and
- promote the development of sustainable industrial and commercial processes having full regard for environmental integrity.

The NPE reinforces the strategy to capacitate MLGH Department of Housing and Infrastructure Development (DHID) and local authorities with adequate resources to rehabilitate and extend sewerage systems and other forms of sanitation and develop and manage solid waste systems.

2.3.2 National Environmental Action Plan

The focus of the National Environmental Action Plan (NEAP) of 1994 is to identify environmental problems and issues, analyse their causes, and recommend necessary interventions. The NEAP was prepared as a comprehensive plan to contain the ever increasing environmental degradation in Zambia. The preparation of NEAP was as a result of Government's desire to update the NCS for the following reasons:

- the economy was undergoing a period of liberalization;
- the main NCS recommendations had been implemented;
- the technical information in the NCS needed updating; and
- there was a requirement by World Bank for a NEAP as a prerequisite for International Development Association (IDA) loan funding.

The NEAP is founded on three fundamental principles:

- the right of citizens to a clean and healthy environment;
- local community and private sector participation in natural resources management; and
- obligatory EIA of major development projects in all sectors.

The overall objective of the NEAP is to integrate environmental concerns into Zambia’s social and economic development planning process.

2.3.3 Environmental Management Act

The Environmental Management Act, 2011:

- continues the existence of the Environmental Council of Zambia (ECZ) and re-name it as the ZEMA;
- provides for integrated environmental management and the protection and conservation of the environment and the sustainable management and use of natural resources;
- provides for the preparation of the State of the Environment Report, environmental management strategies and other plans for environmental management and sustainable development;
- provides for the conduct of strategic environmental assessments of proposed policies, plans and programmes likely to have an impact on environmental management;
- provides for the prevention and control of pollution and environmental degradation; provides for public participation in environmental decision making and access to environmental information;
- establishes the Environment Fund;
- provides for environmental audit and monitoring;
- facilitates the implementation of international environmental agreements and conventions to which Zambia is a party;
- repeals and replaces the Environmental Protection and Pollution Control Act, 1990; and
- provides for matters connected with, or incidental to, the foregoing.

Sections 29 and 30 of Part II of the Act set out the requirements for EIAs and the regulations relating to environmental assessments. A person shall not undertake any project that may have an effect on the environment without the written approval of the ZEMA, and except in accordance with any conditions imposed in that approval. The ZEMA shall not grant an approval in respect of a project if it considers that the implementation of the project would bring about adverse effects or that the mitigation measures may be inadequate to satisfactorily mitigate the adverse effects of the proposed project.

Part IV of the Act makes provision for control of pollution (land, air and water, ozone depletion), the control of general and hazardous waste and the conduct of EIA. The ZEMA has the powers of arrest and prosecution under the Act. Regulations promulgated in terms of the Act include the following:

- Water Pollution and Control (Effluent and Waste Water) Regulations (1993), which provide for the licensing of effluent discharges;
- Air Pollution Control (Licensing and Emissions Standards) Regulations (1996), which require point-source polluters to be licensed;
- General Waste Management Regulations (1993), which require the transportation and disposal of waste, as well as the waste disposal site to be licensed;
- Hazardous Waste Management Regulations (2001), which provide for the storage, transportation, handling, treatment, and illegal trafficking of such waste;
- Pesticides and Toxic Substances Regulations, which stipulate the registration, labelling and packaging, general handling, use and safety, and storage and disposal of pesticides and toxic substances;

- Ozone Depleting Substances Regulations (2000), which detail control measures and permit requirements; and
- EIA Regulations (Statutory Instrument No. 28, 1997), which list activities requiring assessment and responsibilities pertaining to them.

2.3.4 Statutory Instrument No. 28

Statutory Instrument (SI) No.28 under the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997 amongst other requirements sets down the detailed procedures for the preparation of ESIAs, consultations, approvals and monitoring.

2.3.5 Water Supply and Sanitation Act

The Water Supply and Sanitation Act, 1997, consolidates legislative actions under The Water Act, 1948; the National Water Policy, 1994; and the Water Pollution Control (Effluent and Waste Water Regulations), 1993. The responsible agency for these environmental policies is the Department of Water Affairs – Ministry of Energy and Water Development (MEWD). The purpose of these policies is to provide for ownership, control and use of water. The aim is to promote sustainable water resources development with a view to facilitating an equitable provision and adequate and quality water for all users and to ensure security of supply under varying conditions.

The Act provides for the establishment of the National Water Supply and Sanitation Council (NWASCO) which acts as a regulator in the provision of water supply and sanitation services. It mandates NWASCO to regulate the sector in a manner leading to improved delivery, efficiency and sustainability. The Act requires NWASCO to disseminate information to the public on matters relating to water supply and sanitation services.

The Act regulates water supply and sewerage utilities for the purpose of protecting consumers from unjustified tariffs. As specified under the Act, there are four options for local authorities to provide services. The local authority may:

- provide services through a section within the Lusaka City Council (LCC);
- establish a commercial utility as a company licensed and regulated by NAWASCO;
- entrust the management to a private operator while the assets are management by the local authorities or holding company; or
- sell off up to 49% of its equity to a private company and then together form a commercial entity.

2.3.6 The Town and Country Planning Act

The Town and Country Planning Act (CAP 283) provides for: the appointment of planning authorities; the establishment of a Town and Country Planning Tribunal; the preparation, approval and revocation

of development plans; the control of development and subdivision of land; the assessment and payment of compensation in respect of planning decisions; the preparation, approval and revocation or modification of regional plans; and incidental matters.

Part III deals with development plans. Section 16 (2) provides for development plan mapping to illustrate the proposals, and in particular to designate as land subject to compulsory acquisition by the President or by a local or township authority:

(a) land reserved for government or local authority purposes;

(b) areas designated for comprehensive development, and adjacent areas; and

(c) other land in order to secure its vocation for plan purposes.

The same section also provides for designation for compulsory acquisition areas that are not properly laid out that need future treatment, or are obsolete for development needs. It may require the relocation of population or industry or the replacement of open space or any other purpose needed for comprehensive development and development or redevelopment as a whole.

Part VI deals with compensation for refusal of planning permission, including subdivision, if it can be shown that there was material prejudice resulting; and with the circumstances and details of what may and may not be allowable.

Part VII on Land Acquisition (Sections 40 to 44) applies to the provisions of the Land Acquisition Act (Chapter 189), making such adjustments as are necessary to permit the acquisition of land by a local authority.

2.4 Institutional Framework for LWWP and ESIA

2.4.1 Ministry of Mines, Energy and Water Development

The MEWD is responsible for initiating overall national water management policies and for setting national standards and priorities for water development and management.

2.4.2 National Water and Sanitation Council

The NWASCO is a statutory body established by the Water Supply and Sanitation Act No. 28 of 1997. According to the Act in Clause 4, NWASCO is mandated to regulate the provision of water supply and sanitation services. The NWASCO reports through the MEWD, this is in order to keep the regulatory function separate from the water and sanitation implementation function housed under the MLGH. The NWASCO has responsibilities for:

- developing policies regarding water and sanitation;
- setting standards and guidelines regarding water and sanitation;

- licensing water and sanitation utilities and monitoring their performance; and
- taking any necessary actions to ensure efficient and sustainable provision of water and sanitation services.

2.4.3 Zambia Environmental Management Authority

The ZEMA is a statutory body created under the Environmental Management Act of 2011 and is mandated to protect the environment and control pollution so as to provide for the health and welfare of persons, and the environment.

Part VI (49) of the act assigns to the ZEMA certain roles and responsibilities, amongst which are the following:

- formulate and provide standards on the classification and analysis of wastes and formulate and advise on standard disposal methods and means;
- publicize the correct means of storage, collection and disposal of any class of waste; and
- maintain statistical data on the nature, quantity and volume of waste generated and on sites where waste disposal is taking place or has taken place.

2.4.4 Lusaka Water and Sewerage Company Ltd.

LWSC was formed in 1988 under the Companies Act after the Water and Sewerage Department was detached from Lusaka City Council (LCC). It was not until 1990, however, that it commenced operations. Provincial utility status was granted in February 2008 as a Private Limited Liability Company, with the councils of Lusaka (60%), Kafue (20%), Chongwe (10%) and Luangwa (10%) acting as the shareholders.

The Mission Statement of LWSC is “to provide quality water and sanitation services to customers in Lusaka Province at commercially and environmentally sustainable levels”. Their vision is “to be a world class water and sanitation service provider”.

LWSC operates using a non-executive Board of Directors which is appointed by the shareholders.

The LWSC owns and operates water supply and sewerage assets in Lusaka city proper and outlying communities. In addition to the usual planning, engineering, construction, plant operations and maintenance functions, the LWSC also maintains a geographic information system (GIS), mapping capability, computer networks, instrumentation and control (I&C), and administrative functions for governance, management, human resources, service rates, collections, disbursements and finance.

2.4.5 Lusaka City Council

The LCC is the governing local authority for the City of Lusaka, deriving its authority from several Zambian laws, but most immediately, Section 61 of the Local Government Act, which lists 63 functions of local authorities. The LCC responsibilities include, but are not limited to:

- provision and maintenance of supplies of clean water and the establishment of water works and water mains;
- construction and maintenance of sanitary lines;
- establishment and maintenance of sanitation and drainage systems to facilitate the removal of refuse and effluent;
- prohibit and control the use of land and erection of buildings in the interest of public health, safely and orderly development of the Council area; and
- approval to formalize unplanned settlements.

Further important policies. For a detailed description reference is made to Annex 1.

- National Water Policy
- National Conservation Strategy
- National Gender Policy
- National Adaptation Programme of Action on Climate Change
- Sixth National Development Plan
- National Biological Diversity Strategy and Action Plan
- National Forestry Policy
- National Decentralisation Policy
- National HIV and AIDS Strategic Framework

Further important environmental laws and regulations. For a detailed description reference is made to Annex 2.

- Water Resources Management Act
- The Millennium Challenge Act
- Lands and Deeds Act
- Lands Acquisition Act
- Land Conversions of Titles Act
- Occupational Health and Safety Act

Other relevant regulations:

- Public Health Act, 1995 (CAP 295)

- National Health Services Act (CAP 315)
- Local Government Act (CAP 281)
- Zambia Wildlife Act, 1998
- Road Traffic Act, 2002
- Public Roads Act, 2002 (CAP 12)
- Registration and Development of Villages Act (CAP 289)
- National Heritage and Conservation Act, 1989 (CAP 173)
- Forestry Act
- Petroleum Act (CAP 435)
- Explosives ACT (CAP 115)
- Employment of Young Persons and Children Act (CAP 274)
- Anti-Human Trafficking Act, 2008
- Energy Regulation Act (CAP 436)

Further important institutional bodies. For a detailed description reference is made to Annex 3.

- Ward Development Committees
- Community-Based Organizations
- Non-Government Organizations and Cooperating Partners

2.5 EIA Process in Zambia

Following the scope and objectives of the current ESIA study focusing on the identification of a preferred project option (here the selection of a wastewater treatment facility), does not comply with the requirements of the Zambian EIA regulations. Complying with this situation, initial consultations with ZEMA have revealed that a subsequent, individual ESIA study shall be undertaken in accordance with the Zambian regulations (ZEMA standards) at a later stage, when the proposed preferred option is agreed upon by all involved parties. In this context reference is made to Chapter 1.4 ‘Involvement of the ZEMA’.

Respectively, this chapter is describing a) the EIA process in accordance to the Zambian standard and b) the integrative context of the current ESIA study.

2.5.1 EIA Process in Accordance with the Zambian Standard

In terms of Section 29 (1) of the Environmental Management Act No. 12 of 2011, “A person shall not undertake any project that may have an effect on the environment without the written approval of the Agency, and except in accordance with any conditions imposed in that approval”.

The LWWP is likely to have an effect on the environment and falls under the list of projects that require an EIA to be undertaken prior to implementation pursuant to Regulation 3(1) of the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, Statutory Instrument No. 28 of 1997.

In this context Regulation 3 (1) states:

A developer shall not implement a project for which a project brief or an environmental impact assessment is required under these Regulations, unless the project brief or an environmental impact assessment has been concluded in accordance with these Regulations and the Council has issued a decision letter.

In case of the LWWP, the **Lusaka Water and Sewerage Company (LWSC) will act as the developer** of the EIA study.

In line with the Environmental Impact Assessment Regulations, an EIA is conducted in two main phases as follows:

Terms of Reference (ToR) - this phase develops the framework and proposed methodology for assessment of environmental and social impacts. The ToR phase includes a presentation of the proposed project, proposed EIA process and public consultation.

Environmental Impact Assessment (EIA) - this phase builds on the ToR and entails the commencement of the study. The EIA culminates in the development of a draft Environmental Impact Statement (EIS) report, which is submitted to ZEMA for approval (the decision making phase). ZEMA may organise a public hearing on the EIS in the project area if deemed necessary, after which the Agency will make a decision on whether the project is approved; or rejected; or approved subject to meeting certain conditions.

Figure 2-1 provides an overview of the principle EIA process in Zambia.

Figure 2-1: Principle EIA Process in Zambia

The ToRs are to be prepared in accordance with the Environmental Management Act of 2011 as read with the Environmental Impact Assessment Regulations Statutory Instruments No. 28 of 1997 and in line with the ZEMA guidelines for preparation of Terms of Reference.

After approval by ZEMA the EIS document has to be structured to provide summarised information about the project as well as the proposed actions that will be undertaken to achieve the Zambian regulatory requirements for EIA. As such it should contain the following:

- Description of the proposed Project;
- Legal and policy framework;
- Description of the project lifecycle and alternatives;
- Description of the baseline environment and an indication of how additional baseline data will be collected;
- Outline of environmental and social impacts that will be assessed and the methods proposed to asses them;
- The proposed structure and content of the Environmental and Social Management Plan (ESMP);
- The proposed structure and content of the decommissioning and closure plan;
- Public consultation records;
- Declaration of authenticity;
- References; and
- Appendices.

2.5.2 Context with the Current ESIA Process

In general scope and content of the current ESIA study is following the structure of the EIA process in accordance with the Zambian standard, even if formally not acknowledged by ZEMA. The major difference is the focus on providing an overview of environmental and social implications of five project options (eigth sub-options), finally aiming at identifying 'the preferred option' (here Option 5), while, starting a formal EIA procedure in accordance with the Zambian standard necessitates the identification and confirmation of a preferred option as a pre-requisite. Nonetheless, acting in the same local and socio-economic context allows to integrate parts of the current ESIA study as follows:

- National and international legal and policy framework;
- Description of the current wastewater infrastructure;
- Description of the project including alternatives; including
- Outcomes of the first Scoping Meeting with representatives of Manchinchi (including Garden ponds), Chunga and Ngwerere communities;
- Outcomes of community meetings with concerned stakeholders in Manchinchi (including Garden ponds), Chunga and Ngwerere communities;

- Outcomes of individual meetings with Ward Counsilors of Manchinchi (including Garden ponds), Chunga and Ngwerere communities;
- Comprehensive description of the baseline environment: collection of data on the the physical, biological and socio-economic environment including all concerned sites;
- Initial environmental and social impacts, here Option 5;
- The proposed (initial) Environmental and Social Management Plan (ESMP), focusing on Option 5; and
- The initial Stakeholder Engagement Plan (SEP).

2.6 Discharge / Disposal Consent Standards

2.6.1 Effluent Standards

Note: With reference to the Zambian effluent standard, this chapter is exclusively describing the current legislative framework. For any considerations seeking to identify the corresponding technological wastewater treatment design amonst the involved stakeholders (EIB FS Consultant – LWSC – ZEMA) reference is made to Chapter 9 'Further Proceedings'.

Zambia: The quality of treated effluent discharged into surface waters in Zambia is set by standard: Environmental Management (Licensing) Regulations; Effluent quality limits as per SI No. 112 last amended in the year 2013. This standard practically defines the effluent quality to be achieved by a WWTP.

European Union: The effluent standards for WWTPs are set in the Urban Wastewater Treatment Directive (91/271/EEC) for wastewater treatment plants. It shall be noted the EU requirement beside quality requirements also sets requirements for type of sampling and sampling frequency and defines compliance criteria.

Tanzania: The Tanzanian effluent standards are provided in TZS 860: 2005 Municipal and Industrial Wastewaters - General Tolerance Limits for Municipal and Industrial Wastewaters.

Selected parameters are introduced in the Table 2-2 and important issues discussed thereafter.

Table 2-2: Effluent quality parameters (selection) for discharge into surface waters

Parameters	Unit	Zambia	Tanzania	EU	
				10,000 - 100,000 PE	> 100,000 PE
BOD	mg/l	50	30	25	25
COD	mg/l	90	60	125	125
TSS	mg/l	100	100	35	35
Turbudity	NTU	15	300		
Ammonia / Ammonium NH_3 / NH_4	mg/l	10			
Nitrates	mg/l	50	20		

Parameters	Unit	Zambia	Tanzania	EU	
				10,000 - 100,000 PE	> 100,000 PE
Total Kjeldahl Nitrogen (organic + ammonical nitrogen)	mg/l	5 (organic N) (10 ammonical N)	15	15	10
Phosphorus	mg/l	6	6	2	1
Total Coliforms	MPN / 100 ml	25000	10000		
Faecal Coliforms		10000			
E. coli		10			

Zambian effluent standards for COD and BOD are 90 mg/l and 50 mg/l, respectively. The ratio COD/BOD is surprisingly low and not compatible for typical treatment methods. For comparison, the EU standards are 125 mg/l and 25 mg/l. Consequently, the COD standard actually becomes the determining design parameter for Zambian WWTPs, and not – as in other countries – the BOD standard. The impact of this is that WWTPs designed for the COD standard of 90 mg/l, will have a somewhat lower BOD level in the effluent, than the standard of 50 mg/l[1].

Comparing the imposed Zambian and Tanzanian parameters, it can be seen that there are differences and similarities. The largest difference is on turbidity, where the Zambian requirement is 20 times more restrictive than the Tanzanian one. But, with reference to the treatment technology selection altogether, the Tanzanian standard appears to be stricter.

2.6.2 Sewage Sludge Disposal / Reuse Standards

Once the new wastewater treatment facility is implemented sewage sludge is generated every day and need to be handled safely. Facing significantly growing volumes of sewage sludge during the next years is requiring a regulatory framework in order to avoid negative impacts, while also allowing the safe reuse of valuable components contained in the sludge such as mineral fertiliser (nitrate, phosphorus) and organic substance.

Zambia: Currently, no clear system exists for the effective management and regulation of sludge from WWTPs. According to the current legislation, wastewater sludge is therefore categorised either as waste or as hazardous waste.

[1] COWI (2015b): WWTP Options & Sludge Management Plan Report - Final

Republic of South Africa: A comprehensive guideline for utilisation and disposal of wastewater sludge was developed in South Africa in 2006[2]. The guideline was developed to selected appropriate management options for the specific sludge production from WWTPs. The guideline comprises five volumes, whereby volume 2 defines the requirements for the agricultural use of sludge.

The key principle is to select the sludge disposal option based on a simple classification according to three sludge characteristics parameters: Microbiological Class, Stability Class; and Pollutant Class.

The pollution level is defined by the presence of heavy metal contents as shown in Table 2-3 and compared to the current EU regulation in place.

European Union: The current EU Directive for sludge management is the 86/278/EEC Council Directive of the Protection of the Environment, and in Particular the Soil, when Sewage Sludge is Used in Agriculture of 12 June 1986. The 86/278/EEC aims to encourage the use of sewage sludge in agriculture, hereto defines a set of conditions.

Sludge shall be treated before being used in agriculture. However, EU member states may authorise the use of untreated sludge, if it is injected or worked into the soil. In this context, treated sludge is defined as having undergone “biological, chemical or heat treatment, long-term storage or any other appropriate process so as significantly to reduce its fermentability and the health hazards resulting from its use".

It should be noted that Directive 86/278/ EEC was adopted almost 30 years ago and only sets limit values for seven heavy metals as shown in Table 2-3 below. Most EU countries have implemented national regulations with stricter limit values.

Table 2-3: Sewage sludge quality parameters (selection)

Parameters	Unit	RSA	EU
Cadmium	mg/kg dry matter	85	20 - 40
Copper		4300	1000 - 1750
Nickel			300 - 400
Lead		840	750 - 1200
Zinc			2500 - 4000
Mercury			16 - 25
Chromium		3000	not regulated
Microbiological parameters			
Faecal coliforms	CFU/g_{dry}	$1x10^6$	not regulated
Helminth ova	total viable ova/g_{dry} in 2 of 3 samples	$1X10^7$	

[2] Guidelines for the Utilisation and Disposal of Wastewater Sludge Volume 1 of 5 Selection of Management Options, prepared for the Water Research Commission, Golder Associates Africa, WRC Report No. TT 261/06 March 2006

3 DESCRIPTION OF THE CURRENT WASTEWATER INFRASTRUCTURE

Due to a tremendous growth of population, high immigration rates and socio-economic conflicts, Lusaka nowadays is facing serious environmental and social problems. Urban growth in Lusaka has resulted in increased wastewater generation. However, disposal and treatment systems were not implemented in order to meet the demand and overall investments into sanitation infrastructure have not been sufficient over the last decades. The problem is exacerbated as today significant parts of the wastewater infrastructure (wastewater treatment plants and sewerage network) were constructed more than 40 years ago.

The Lusaka Waste Water Project (LWWP) aims to determine and implement required measures for the improvement of existing wastewater treatment facilities as well as the sewer network and to specify associated investment needs.

First a general overview of project locations is provided followed by site specific information of the existing conditions at the relevant wastewater infrastructure facilities. Finally, environmental and social implications are recorded based on observations made during site visits, interviews with the WWTP operators and community members living nearby. Apart from the technical conditions this information provides a first impression of the environmental and social pressure around the sites.

In the context of the ESIA study the following wastewater facilities are considered:

- Manchinchi WWTP including the Garden Ponds
- Chunga WWTP,
- Ngwerere Sewage Ponds,
- Pumping stations CSU-14; CSU 16-20 in the Manchinchi sewershed, and
- CSU-9 – main collector into Manchinchi WWTP.

Prior to the description of the facilities the following Figure 3-1 is providing an overview of the wastewater treatment facilities located in the City of Lusaka.

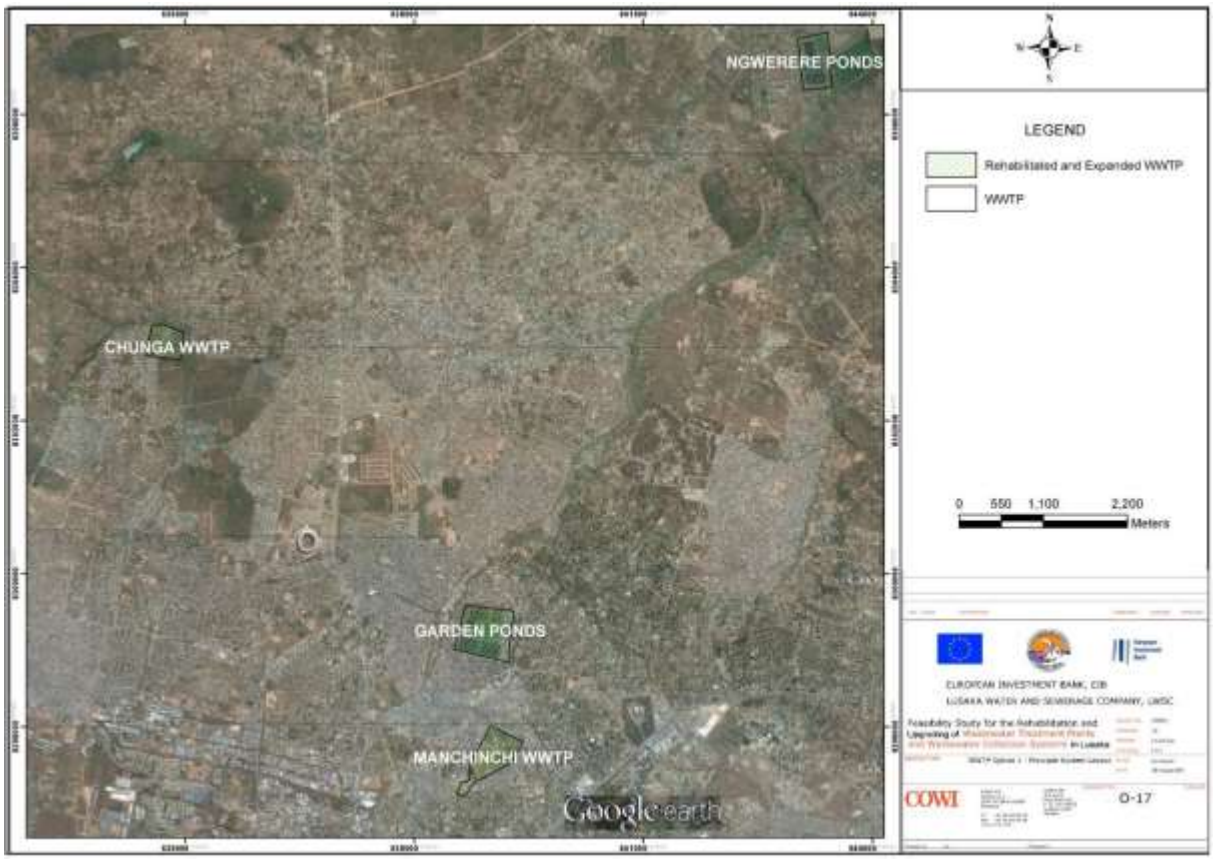


Figure 3-1: Overview of Wastewater Treatment Facilities in Lusaka City

Source: COWI (2015b): WWTP Options & Sludge Management Plan Report - Final

3.1 Manchinchi WWTP

3.1.1 Description

The Manchinchi WWTP is located in Ngwerere Ward near the center of Lusaka and is covering an area of around 28 ha. It is surrounded by the three high density residential areas of Chilulu, Garden and Luangwa compounds, and a relatively low density residential area, namely Northmead.

The three adjacent compounds (Chilulu, Garden and Luangwa) have no access to the sewer network system and thus use pit latrine as well as septic tanks. This is despite the geographical proximity of the two compounds to the Manchinchi WWTP. Northmead, on the other hand, is connected to the sewer network system.

Figure 3-2 shows the location of the Manchinchi WWTP.

Despite the reliance on on-site facilities for sanitary service, piped water supply is provided to the two high density residential areas. Households are connected to the LWSC main water supply network

system and majority of the households have individual household connections. Water supply is provided by standpipes outside the houses and/or piped water within the household yards.

3.1.2 Condition Assessment, Key Challenges and Major Shortcomings

Manchinchi WWTP was constructed in the 1950s and expanded in the 1960s followed by further expansion in the 1970s. However, since that time no upgrading of the works has taken place and as a result it is providing little treatment of the influent wastewater due to the dilapidated state of the plant and failure of mechanical and electrical items. The structure of the works is mainly concrete and is predominantly sound although there are instances where the concrete has spalled and the exposed reinforcement has been badly corroded. This is due to emissions of hydrogen sulphide caused by the septicity of the influent sewage.

The WWTP has a design capacity of 36,000 m^3/d, however the plant is hydraulically overloaded. Additional to the inflowing wastewater, a significant volume of domestic/industrial wastewater and faecal sludge from pit latrines is supplied by tankers.

Today Manchinchi WWTP is more or less un-operational. Presently, most part of the WWTP is bypassed, and wastewater is directed to the maturation ponds at Garden ponds.

The co-settled sewage sludge is marginally thickened and dried on the drying beds, during the rainy season it is stored in the sludge lagoons (2). The lagoons are partly overgrown with weed and most likely do not have a protective basis layer. Semi-dry sludge is sold to local agriculture and horticulture small scale farmers on demand.

The treated wastewater is transferred to the Garden ponds, originally designed in the 1980s as maturation ponds for effluent disinfection. Further information is provided in the next chapter.

3.1.3 Environmental and Social Implications

The following observations indicating current pressing issues have been made at Manchinchi WWTP:

- Reception station for faecal sludge poorly managed, thus generating smell and attracting vectors (mosquitos);
- The surrounding wall around the WWTP area is partly destroyed; open space is used for disposal of individual solid waste, posing a health threat;
- Residents regularly cross the WWTP area despite the presence of safeguard personnel;
- No covers on manholes all across the WWTP, and lagoons are not fenced;
- Residential areas in main wind direction (East-West) are directly affected by foul gases;
- Solid waste resulting from wastewater treatment process has accumulated over time and ‘invites’ neighbors to dispose off their domestic solid waste;

- Farmers are already taking sludge from the open lagoons, paying to the WWTP staff per ton ZMW 7.5 (corresponding to 0.85 EUR in July 2015). No sludge quality monitoring is established. This presents not only a danger to public health, but also to the farmers' own health especially while handling the sludge, as they do not use any personal protection equipment (gloves, boots, mouth and nose covering masks).
- Residents and their representatives do not perceive any benefit from the WWTP for the community, but as an annoying, undesired installation;
- Community leaders perceive the unused space in the WWTP compound as a waste of land and requested LWSC already to hand it over to the community for residential constructions.

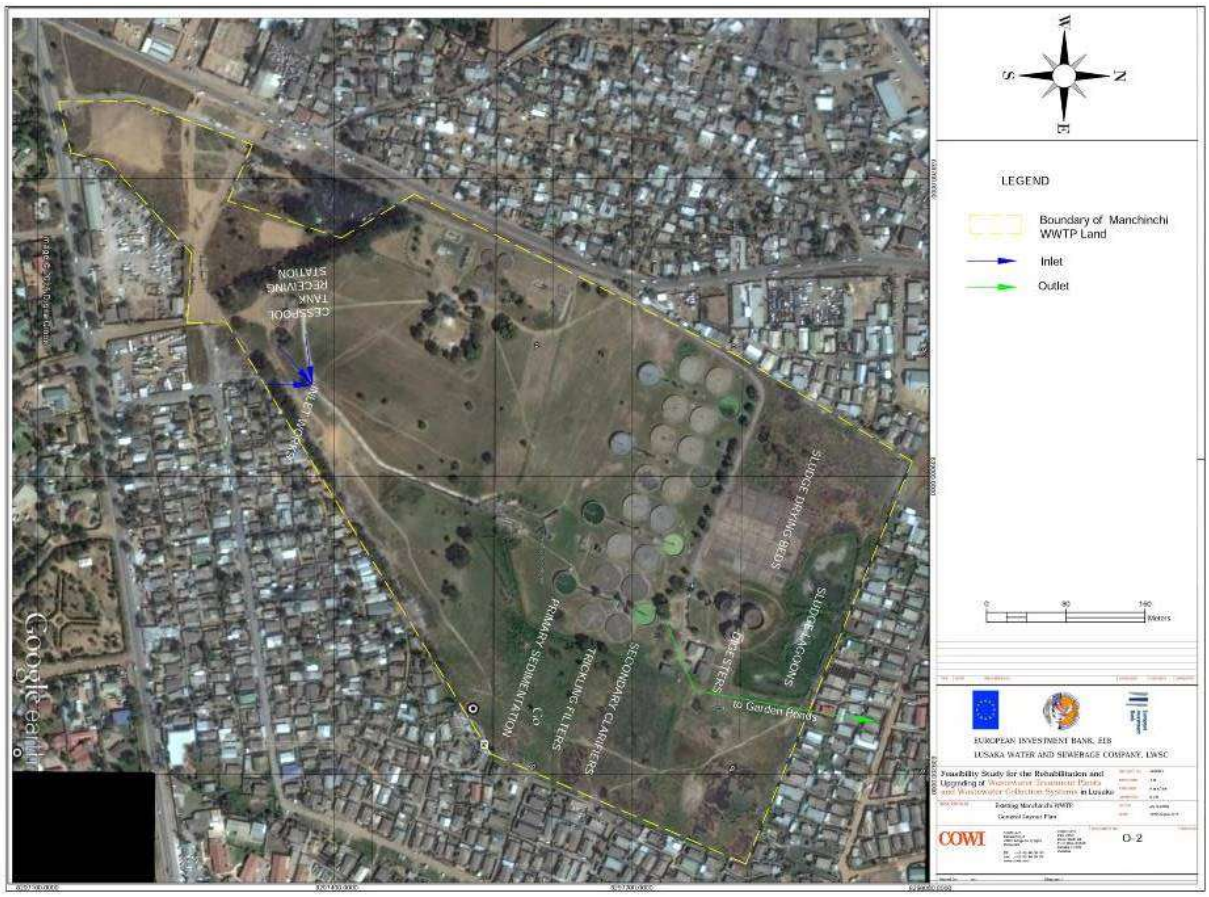


Figure 3-2: Manchinchi WWTP and surrounding settlements

Source: COWI (2015b): WWTP Options & Sludge Management Plan Report - Final

3.2 Garden Sewage Ponds

3.2.1 Description

Linked to the Manchinchi WWTP are the Garden Sewage Ponds. These ponds are located within Garden compound but about 1 km further north of the Manchinchi WWTP and are the final purification facilities for the treated effluent from the Manchinchi WWTP. The total area is about 44 hectares.

Like the Manchinchi WWTP, the Garden ponds are surrounded by residential housing developments.

The land around the Manchinchi WWTP and the Garden Ponds are zoned as residential areas. Therefore, residential developments surround the Manchinchi WWTP and the Garden ponds, and all the available land allocated for residential developments has been taken up and housing units constructed. In addition, no buffer area exists anymore between the Manchinchi WWTP and the residential areas. However, the Garden Road separates the WWTP and the housing units on the west. The same can be observed with the Garden ponds. Public roads separate south, west and north of the pond system from the residential areas. Nonetheless, the land between the roads and the pond system is used by local communities for horticulture activities, mainly the cultivation of various vegetables. Hereto, water and effluent from the pond system is used for irrigation.

3.2.2 Condition Assessment, Key Challenges and Major Shortcomings

The Garden ponds were designed in the 1980ies as maturation ponds to disinfect the treated effluent from Manchinchi WWTP. The system is consisting of 8 ponds operated as 2 line system with 4 individual ponds each with a gravity based flow regime as shown in the next Figure 3-3.

The exact water depths are not known. The total volume of the ponds is expected in the interval 250,000-300,000 m^3 however all ponds are more or less filled with settled sludge.

Due to the poor treatment effectiveness of the Manchinchi WWTP, deposition in the treatment streams, settling of sludge and partly coverage with weed the performance of the ponds has been low. In 2012 and 2013 some ponds have been de-sludged.

Today, the ponds are in poor condition, both in terms of its physical structure but also representing a massive risk to the population and the environment. This is clearly reflected in the effluent quality parameters (see Chapter 6.1.3 ‘Impact on Receiving Waters’).

The situation is worsened because the proposed desludging of the ponds is taking place at a slow pace due to financial constraints. The situation may further worsen in the rainy season, as no meaningful treatment may be taking place in those over-silted ponds with very shallow retention depth, hence overflows or spillages of effluent into surrounding community and environment has potential to bring LWSC into disrepute with the neighbouring community and/or the regulator ZEMA.

3.2.3 Environmental and Social Implications

At Garden Ponds, the following observations on current pressing issues potential have been made:

- Around the area the protective fence is completely missing presenting a permanent risk of drowning incidents to pedestrians especially to children - not only during the day, even more in the evening and night.
- Massive smell covers the surrounding residential area due to the generation of fouling gases.

- All ponds more or less weeded; last ponds with significant growth of water hyacinths.
- Effluent more or less stagnant with massive attraction of vectors, posing a permanent threat to public health.
- Local population – children, women, men, either walking, pushing wheelbarrows or on bicycles is using the pathways between the ponds to reach the main road thus being exposed to the risk of drowning.
- LWSC maintenance staff (removal of solid waste, de-weeding, grass cutting) fully exposed to unsafe working conditions and related health risks (not using personal protection equipment such as gloves, boots, and nose-and-mouth covering masks).
- Flowerpot producers around the ponds fetch water from the ponds to irrigate their plants for sale; although not allowed they do this in broad daylight. This threatens not only their own health (not using personal protection equipment such as gloves, boots, and nose-and-mouth covering masks) but also the health of their clients.

Figure 3-3: Garden Sewage Ponds and surrounding settlements

Source: COWI (2015b): WWTP Options & Sludge Management Plan Report - Final

3.3 Chunga WWTP

3.3.1 Description

Chunga WWTP is located in the Mwambeshi Ward and is covering an area of 14 ha. Two main types of land uses are distinguished: residential developments (dwellings) and a grave yard. The residential

dwellings are confined to the north, northeast and northwest, west and southwest of the immediate boundaries of the WWTP. The grave yard, Ngwerere grave yard, occupies the south and southeast of the plant. Figure 3-4 shows the location of the Chunga WWTP.

The land bordering directly to the Chunga WWTP is used for cultivating vegetables by the local community. This practice is particularly common to the land lying north of the plant; the land between the Chunga River and the Chunga WWTP.

New residential properties are being developed around the Chunga WWTP. These developments, nonetheless, are concentrated to the western and northern sides of the plant. Residential developments on the northern side of the plant are across the Chunga River while those on the western side are immediately on the boundary. Therefore, a buffer area is naturally created on the northern side of the plant while no buffer exists between the housing developments and the WWTP in the western side of the plant. More conflicts are thus anticipated in this part of the WWTP site.

More residential property developments are expected to extend further. Futures partial planning of the area hinges on residential property development. All the available land around the Chunga WWTP has been offered for residential property development by the LA, the Lusaka City Council.

3.3.2 Condition Assessment, Key Challenges and Major Shortcomings

Chunga WWTP was constructed in the 1970s and technologically is in a poor state as has not received any rehabilitation or upgrading so far. Different from Manchinchi WWTP, Chunga receives a mixed wastewater with significant input of industrial wastewater for treatment. As with Manchinchi WWTP, the structure of the works is predominantly concrete and brick and is mainly sound although there is some corrosion resulting from emissions of hydrogen sulphide caused by the septicity of the influent sewage. The WWTP has a capacity of 9,100 m^3/d, but is hydraulically overloaded.

The WWTP area is gradually sloping from the gate to the discharge point, what allows the gravity based operation of the system. Except, sludge needs to be re-pumped to the sludge beds or lagoon.

Receiving a mix of industrial and domestic wastewater is reflected in the quality monitoring (see Chapter 6.1.3 ‘Impact on Receiving Waters’).

In general, the sludge management practice as recorded at Manchinchi WWTP is also applicable for Chunga WWTP. The co-settled sludge is marginally thickened and dried on the drying beds, during the rainy season it is stored in a sludge lagoon. Parts of the drying beds are completely overgrown with weed and shrubs. The lagoon most likely does not have a protective basis layer.

Semi-dry sludge is sold to local agriculture and horticulture small scale farmers on demand without quality monitoring.

The treated effluent without prior disinfection is discharged directly into the Chunga River, which drains into the Kafue River.

3.3.3 Environmental and Social Implications

The following observations on current pressing issues and conflict potential have been made:

- Chunga WWTP suffers from the complete lack of a boundary fence, thus there is no security.
- Farmers are already taking sludge from the open lagoons, paying to the WWTP staff per ton ZMW 7.5 (corresponding to 0.85 EUR in July 2015). Given the fact that this sludge is a result of the treatment of a mix of domestic and industrial it is highly possible that both pathogens and heavy metals still exist in the sludge. This presents not only a danger to public health, but also to the farmers' own health especially while handling the sludge, as they do not use any personal protection equipment (gloves, boots, mouth and nose covering masks).
- Some manholes in the WWTP are not covered, and wastewater streams are flowing fast in about 3m depths towards Chunga stream. As the compound is not fenced children could easily enter to enjoy the place, and fall into these manholes, which are wide enough to pose a dangerous trap for adults.
- Chunga River is a solid waste loaded water body, which carries solid waste from a number of residential areas upstream. Like in Manchinchi community, the overall environmental sanitation conditions of Chunga community demands for immediate action and community education strategies.
- Across Chunga River and facing Chunga WWTP a new residential area (obviously middle to higher-middle income) starts to grow. Odor caused by the treatment system could impact the future residents there, too, potentially resulting in further resistance against the WWTP in this location.

Figure 3-4: Chunga WWTP and surrounding settlements

Source: COWI (2015b): WWTP Options & Sludge Management Plan Report – Final

3.4 Ngwerere Sewage Ponds

3.4.1 Description

The Ngwerere sewage ponds are located in Kapwayambale Ward; here Lusaka District shares a boundary with Chongwe District. The ponds are located in rural areas about 12 km northeast of Lusaka city centre. The total area is about 24 hectares.

The area where the sewage ponds are located is predominantly an agricultural area characterized by smaller individual plots and some larger extensions either vegetable production under irrigation schemes or poultry breeding. Nonetheless, over the years, the land use in the Ngwerere area is slowly changing from agricultural to mixed-development use.

A high density residential area, Silvia Masebo Compound, is located to the immediate north and east of the secondary ponds. The high density residential area started as an informal settlement but has been formalized in the year 2008. While, the eastern side of the ponds is bordered by a commercial farmer which also can be found in north-eastern part of the wider area.

Nonetheless, despite a gradual change in the land use from agricultural to mixed-development use, majority of the landowners in the Ngwerere area are still holding on to their small holding land lease titles and have continued with their agricultural and/or horticulture activities. Small holding leases cover a minimum of 20 hectares of land area and bind a land lease owner for a specified land use which is normally agricultural activities. In the recent past, however, majority of the small holders have changed the uses to residential property. As such, a lot of residential properties are being constructed in the area as indicated in the next Figure 3-5

3.4.2 Condition Assessment, Key Challenges and Major Shortcomings

The Ngwerere sewage ponds were designed as maturation ponds to disinfect the sewage effluent from the residential settlements of Kabanana, parts of Mandevu, Emmasdale as well as parts of Rhodes Park. The pond system consists of 4 ponds, thereof 2 primary and 2 secondary ponds and is in the ownership of LWSC. From the operational point of view the system looks well maintained.

The exact water depth is not known, but is estimated at 1-1.5 m, i.e. total volume is some 170,000 m^3.

Once being completely fenced, today most parts of the fence are missing. Taking advantage of this situation, some agricultural plots are cultivated inside the originally fenced area. As shown in the Figure 3-5, today only the area directly surrounding the ponds is in the ownership of LWSC. After treatment the effluent is discharged into a small tributary of the Ngwerere River.

3.4.3 Environmental and Social Implications

The following observations on current pressing issues and conflict potential have been made:

- Physical security and public health issues: no fence and no barriers are in place around the ponds pose a high risk for drowning incidents for both children and adults. It further enables open access for everybody to use the partly treated water for illegal and unsafe irrigation. Digging of shallow wells for ‘drinking water supply’ in the community is associated with potential infiltration of unsafe waters from the ponds, but the deeper boreholes equipped with hand pumps are blocked by silt.
- Availability of Land for WWTP extension: Today only the area around the ponds is owned by LWSC. Respectively, due to limited space in the ownership of the LWSC future extension areas are to be acquired from private owners. Most plots around the ponds are cultivated agricultural plots with obviously good soil fertility, which will definitely impact the required investment in case the site is identified as preferred option.
- Sludge and Effluent Reuse: Further north of the site extensive agricultural farms can be found. In June 2015, these farms cultivated grains irrigated by rotating pivot centre irrigation systems, most likely fed by groundwater from wells. Here effluent might offer a potential alternative.

  The small farms surrounding the ponds are irrigated with water from the ponds. As stated by LWSC this practice is forbidden, however no effective control mechanisms are established. Especially during the weekend significant effluent volumes are pumped off for irrigation.

These farmers might be interested in the future safe reuse of the effluent, however this would be associated with changes in the current crop regime (mainly vegetables) or the establishment of a treatment standard that allows for using the effluent for agricultural irrigation.

Reference is made to Chapter 4.5 ‘Outcomes of the Scoping’ where most of the observed issues were also addressed during the Scoping Workshop.

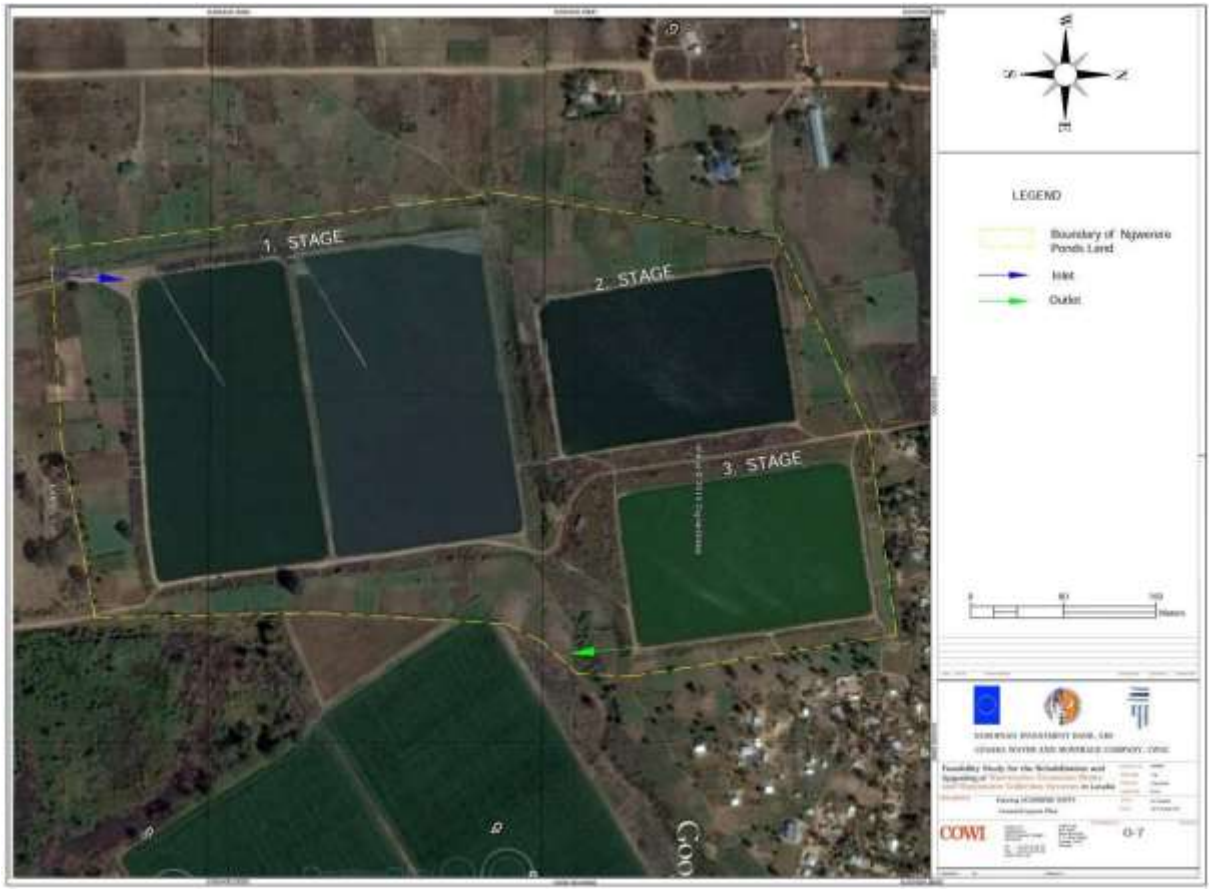


Figure 3-5: Ngwerere sewage ponds and surrounding settlements

Source: COWI (2015b): WWTP Options & Sludge Management Plan Report – Final

3.5 Main Collector CSU-9

The Manchinchi South main collector has a large tributary area. The alignment of the interceptor starts in the Woodlands area in the south east of the city and receives flows from several pumping stations before finally transferring the collected wastewater to the Manchinchi WWTP.

The sections between Independence Avenue and Manchinchi WWTP and from Manchinchi WWTP to Garden Ponds – called CSU-9 - do not have adequate hydraulic capacity, especially during wet weather. To compound the matter, a large retail and commercial complex known as Levy Mall has recently been constructed on Church Road, at the north west quadrant of the junction with Kabelenga

Road, which is discharging into the main collector near Evelyn Hone College (between Independence Avenue and Manchinchi WWTP). Also new areas will be sewered, e.g. along the Kafue Road, which will eventually drain into CSU-9 (COWI 2015b).

The existing Manchinchi South interceptor is approximately 40 years old and constructed from asbestos cement (AC) pipe. Due to its age the pipe has deteriorated and this deterioration has contributed to reduced hydraulic capacity and high leakage rates. An overview of the location and alignment is provided in the Figure 3-6.

3.6 Pumping Stations CSU-14; CSU-16 – CSU-20

Altogether 6 wastewater pumping stations (PS) are subject to rehabilitation/upgrade under the Lusaka Waste Water Project as follows:

- CSU-14 - Noxious PS located in the central commercial area (Kanda Road)
- CSU-16 - Mass Media PS
- CSU-17 - Woodlands PS
- CSU-18 - Kabwata PS
- CSU-19 - Kamwala PS
- CSU-20 - Lumumba PS located at the Central Bus Station (Lumumba Road)

All PS except CSU-14 (Noxious PS) are located in the Manchinchi catchment area, while CSU-14 is located in the Chunga/Matero catchment area. This fact has also consequences for the implementation of the LWWP. Execution of the FS for PS CSU 16-20 are in the responsibility of the EIB FS Consultant, whereas, PS CSU-14 has been included in the FS being prepared by the WB Consultant, SMEC International Ltd.

Being constructed in the same time period (1980) and having not received substantial rehabilitation or upgrading since then, all PS are in poor condition. All PS are constructed as open concrete structures, consisting of collection/grid chamber, pumping chamber(s), valve chamber, and scaffold. Additional to the equipment listed before, Lumumba and Kamwala PS have a stable housing covering the pump chamber(s).

Allowing the PS operation during energy cut off, Noxious PS, Lumumba PS, Mass Media PS and Kabwata PS are equipped with diesel generators. An overview of the location of the pumping stations is provided in the Figure 3-6.

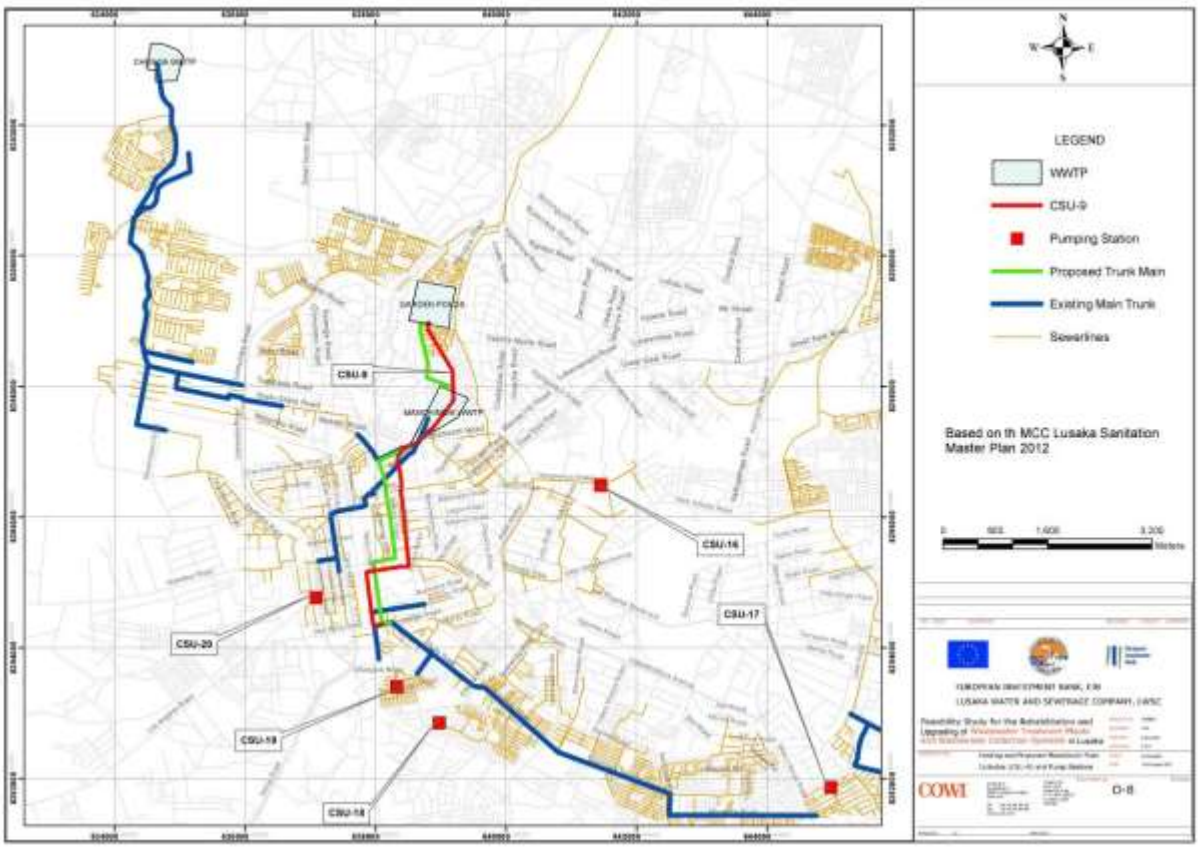


Figure 3-6: Alignment of interceptor CSU-9 and locations of wastewater pumping stations

Source: COWI (2015b): WWTP Options & Sludge Management Plan Report - Final

4 DESCRIPTION OF THE PROJECT INCLUDING ALTERNATIVES

Under the **Lusaka Waste Water Project five (5) relevant main options on wastewater treatment plants, sub-divided into eight (8) project variants** were investigated. This option analyses refers to the identification of the most appropriate solution with view to technical, operational and economic conditions.

Having analysed the evolution, investigation and selection process for Options 1 – 4 (A-C) in the Draft ESIA Report the present chapter is providing a brief summary focusing on the technological solutions and describing the identification and recommendation of the **'preferred' option.**

The Option Analysis Report prepared under the EIB FS and submitted to EIB and LWSC at October 10, 2015, focussed on four (4) main option and three more variants (here sub-options of one main option).

As preliminary outcome this report recommended Option 4B for implementation. Subsequently, it was decided amongst the involved stakeholders to analyse one more option, Option 5. The corresponding Draft Analysis Report was submitted by the EIB FS Consultant to EIB and LWSC in April 2016 and was finally accepted in May 2016.

In the context of the Draft ESIA study, the option analysis on wastewater treatment facilities is representing a central document. All considered options and/or sub-options (1-4C) were subject to the assessment of associated environmental and social impacts. Subsequently and in line with the new Option 5, the current Draft Final ESIA study presents the environmental and social impacts and also mitigation measures in the Environmental & Social Management Plan (ESMP) for this Option 5, only.

4.1 Option Analysis on Wastewater Treatment Facilities

In the context of the options analyses on wastewater treatment facilities the following alternatives have been investigated:

Option 1: Rehabilitating/upgrading and expanding the Manchinchi and Chunga WWTPs, including a possible waste to energy option;

Option 2: Maintaining the Manchinchi and Chunga WWTPs, but with a combined sludge management and disposal solution; and

Option 3: Abandoning Chunga WWTP and transferring all wastewater to Manchinchi WWTP.

Option 4 includes the abandoning both Manchinchi and Chunga WWTPs and transporting all wastewater through a new collector to the current location of the Ngwerere ponds and constructing a new, centralised treatment plant accommodating the wastewater of the current and future Ngwerere wastewater system. Under this option four variants have been assessed:

Option 4: Treatment concept based on stabilisation ponds technology and sludge treatment in sludge drying beds. All ponds lined with membrane and geotextile;

Option 4A: Treatment concept based on stabilisation ponds technology and sludge treatment in sludge drying beds. Anaerobic and facultative ponds lined with membrane and geotextile. Maturation ponds are not lined;

Option 4B: Treatment concept based on trickling filters and anaerobic digestion of sludge under replacement of the existing pond system;

Option 4C: Treatment concept based on activated sludge and anaerobic digestion of sludge under replacement of the existing pond system; and

Option 5: Upgrading (replacement) of the existing Ngwerere pond system; Upgrading (re-construction) and expanding of the Chunga WWTP based on trickling filter technology, including a possible waste to energy option.

Under all investigated options the Garden Ponds are subject to decommission.

Table 4-1 and Table 4-2 provide a summary outcome of the investigated technological options.

Table 4-1: Options 1-3: Summarised outcomes of project and technology options

<table>
<tr><th>Treatment step</th><th>Option 1</th><th>Option 2</th><th>Option 3</th></tr>
<tr><td>Wastewater treatment</td><td colspan="3">Trickling filters with nitrification</td></tr>
<tr><td>Effluent disinfection</td><td colspan="3">Chlorination</td></tr>
<tr><td>Gas utilization (Sludge-to-energy)</td><td colspan="3">Anaerobic stabilisation of surplus sludge with gas utilisation</td></tr>
<tr><td rowspan="2">Sludge treatment</td><td></td><td>Gravity thickening of surplus sludge and transfer to Manchinchi WWTP</td><td></td></tr>
<tr><td colspan="3">Storage of stabilised sludge in lagoon in wet season and dewatering in sludge drying beds in the dry season</td></tr>
<tr><td>Garden Ponds?</td><td colspan="3">Decommissioned</td></tr>
</table>

Source: COWI (2015b): WWTP Options & Sludge Management Plan Report - Final

Table 4-2: Options 4 (4-4C) and 5: Summarised outcomes of project and technology options

Treatment step	Option 4	Option 4A	Option 4B	Option 4C	Option 5
Wastewater treatment	Lined anaerobic ponds Lined facultative ponds		Trickling filters with nitrification	Activated sludge	Trickling filters with nitrification
Effluent disinfection	Lined maturation ponds	Maturation ponds	Chlorination		
Gas utilization (Sludge-to-energy)	None		Anaerobic stabilisation of surplus sludge with gas utilisation		
Sludge treatment	Storage of stabilised sludge in lagoon in wet season and dewatering in sludge drying beds in the dry season				
Ngwerere Ponds?	System extended		Replaced by conventional WWTP		

Source:

Options 4-4C: COWI (2015b) - WWTP Options & Sludge Management Plan Report – Final
Option 5: COWI (2016) - Feasibility Study - Final (Appendix H - Option 5 Analysis)

4.2 Summary of Major Impacts – All Options

Despite the fact that the present report shall focus exclusively on Option 5, a compact summary of most significant factors shaping the impacts associated with each individual treatment option is presented and visualised in this chapter for understanding of the development process of Option 5 (refer to Table 4-3).

Option 1 was considering the upgrading of the existing Manchinchi and Chunga WWTPs. This would take place at the existing sites without any additional land requirement. But, as a result of the implementation the WWTP infrastructure and equipment would move closer to the densly populated settlements surrounding the WWTP sites and need to be mitigated properly.

Option 2 was also considering the upgrading of the existing Manchinchi and Chunga WWTPs. However, under this option sludge was considered being transferred to Manchinchi WWTP for treatment and processing. In principle all impacts identified for Option 1 would also apply, but all sludge has to be handled in the densely populated city center and need to be mitigated properly.

Option 3 was considering the extension of Manchinchi WWTP including the transfer of all wastewater and sludge from Chunga WWTP. No additional land would be required. In principle all impacts identified for Option 1 would also apply, but all sludge and wastewater has to be handled in the densely populated city center and need to be mitigated properly. While, Chunga WWTP would be abandoned.

Options 4-4C: The major advantage of all options related to the extension (4/4A) or replacement (4B/C) of the Ngewerere pond system has been the fact that practically wastewater treatment is abandoned from the urban city center. On the other hand, all wastewater has to be transferred to the Ngwerere site what necessitates the construction of a new transfer infrastructure.

Option 4C has been identified to be associated with a variety of negative impacts such as the highest energy consumption, generation of CO_2 emissions and sludge generation. The proposed treatment technology (activated sludge) would be new to LWSC.

Options 4/4A are connected with many operational advantages resulting from the extension of the ponds without any technological equipment. However, due to the massive land requirement of 350 ha in combination with the obligatory need of large-scale resettlement makes the implementation of these options unrealistic.

Option 4B would include the replacement of the existing pond system by a trickling filter based wastewater treatment plant. In the year 2040 a moderate extension of the site by 10 ha (total area ~ 34 ha) would be required. From the operational point of view, Option 4B would have a comparatively high energy demand, CO_2 emissions and sludge generation.

Option 5 – the preferred option: As the environmental and social impacts associated with Option 5 are the specific subject to this report, reference is made to Chapter 7. However, allowing an easier understanding comparing with the other options selected main findings are presented already in the following Table 4-3.

Table 4-3: Summary of major environmental and socio-economic impacts for the reference year 2025

	Option 1	Option 2	Option 3	Options 4/4A	Option 4B	Option 4C	Option 5
Treatment technology	trickling filter			pond system		activated sludge	trickling filter
Environmental parameter							
Mixing of wastewater flows	no	no	yes	yes	yes	yes	no
Land requirement (ha)	28 / 14	28 / 14	28	350	24	24	14 / 24
Energy demand after recovery (MW/y)	6846	6871	9449	3083*	9734	18945	7674
CO_2 emission (t/y e-emission)	8910	8943	12295	4010	12657	24631	9978
Sludge generation (t/y with 50% DS)	15440			10840	17472	35948	17520

	Option 1	Option 2	Option 3	Options 4/4A	Option 4B	Option 4C	Option 5
Area needed for agricultural sludge reuse (ha/y)	920			628	1012	1597	1752
Socio-economic parameter							
Resettlement required - WWTP sites?	no	no	no	yes	no	no	no
Resettlement required - Wastewater transfer?	no	no	no	yes	?	?	?

* - no energy recovery possible

4.3 Option 5 – The Preferred Option

As indicated before, Option 4B was proposed initially to be considered as preferred option. **But, given the fact that the additional analysis of Option 5 has proven its economic viability and beneficial character for the LWSC this option was finally selected as the preferred option.**

Under Option 5, a wastewater treatment structure with two WWTPs – New Ngwerere and New Chunga WWTPs will be considered. Manchinchi WWTP including the Garden ponds are proposed to be decommissioned and sold.

Ngwerere site: The new treatment concept is based on trickling filters; anaerobic digestion of sludge and potential biogas utilisation will be considered. Hereby, the existing Ngwerere pond system will be replaced. Considering the 2025 loads the new treatment system will be implemented within the existing 24 ha site currently in the ownership of the LWSC. In the year 2040 a moderate extension of the area by ~ 10 ha is envisaged.

Chunga WWTP: From the technological point of view the new treatment concept is also based on trickling filters; anaerobic digestion of sludge and potential biogas utilisation. The new treatment system will be implemented within the existing 14 ha site in the ownership of the LWSC. In the year 2040 no extention of the area is required.

Manchinchi WWTP: Altogether, the current area of Manchinchi WWTP is 28 hectares. Following the technical concept of the EIB FS Consultant the site will be divided into three sections, a southern portion, a central portion and a northern portion. The central section, today covered by the faecal acceptance station will continue operation by receiving septage from the cesspool tankers. This section is covering an area of 2.3 hectares; respectively 26 hectares are proposed to be sold. For this purpose the following activities are proposed:

- Demolition of structures and buildings;
- Transport and disposal of construction waste at Chunga landfill; and

- Levelling of land.

Sale of the excess areas is proposed after completion of the project and is expected to take place over a period from 2019 to 2025.

Garden Ponds: Along with the Manchinchi WWTP the Garden ponds consisting of 8 ponds operated as 2 line system with 4 individual ponds each with a gravity based flow regime. The total area is covering 44 hectares.

Decommissioning of Garden Ponds includes:

- Construction of boundary wall to avoid further encroachment;
- Emptying, collection, transport and reuse of sludge in agriculture; and
- Levelling of land.

Estimated costs for the decommissioning of the site are 1,503,200 Euro.

Wastewater transfer: All wastewater currently treated in Manchinchi WWTP, but also wastewater generated in the Ngwerere sewershed is transferred via a new main collector to the Ngwerere site.

Figure 4-1 and Figure 4-2 are providing general layout plans of the New Chunga and New Ngwerere WWTPs (Option 5).

Figure 4-1: Option 5: General layout plan of New Chunga WWTP.

Source: Option 5: COWI (2016) - Feasibility Study - Final (Appendix H - Option 5 Analysis)

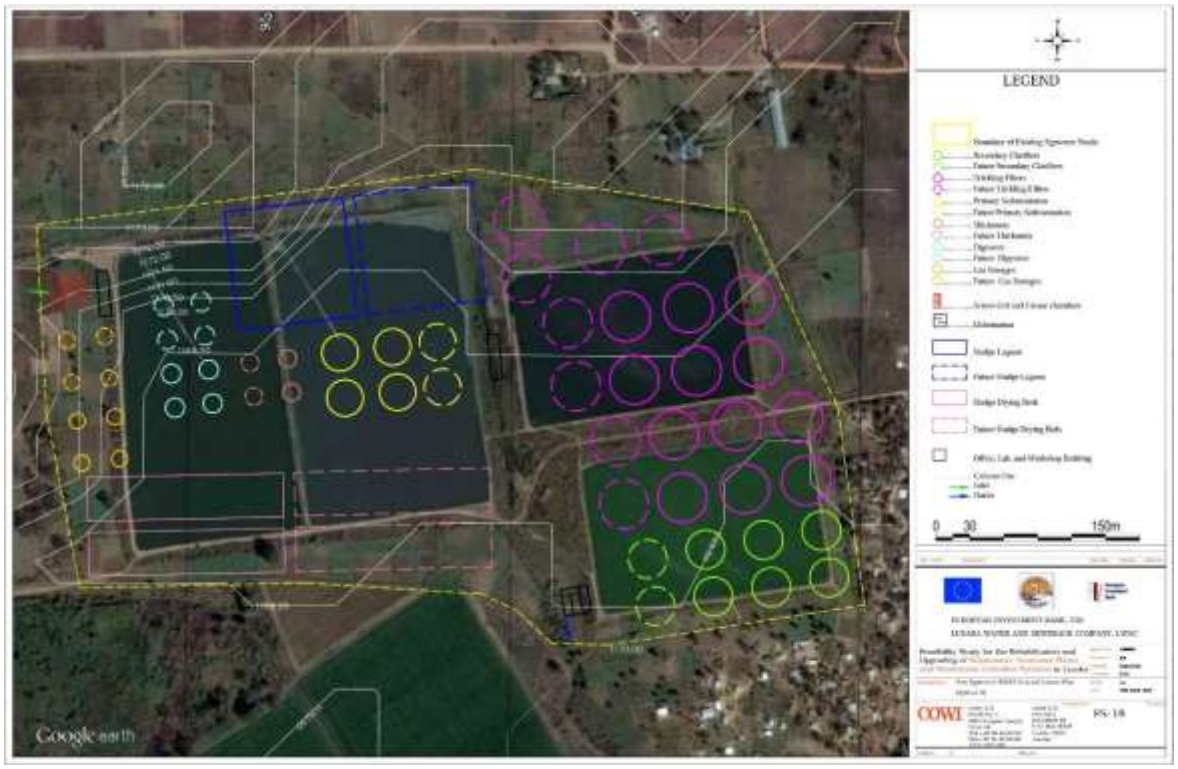


Figure 4-2: Option 5: General layout plan of New Ngwerere WWTP.

Source: Option 5: COWI (2016) - Feasibility Study - Final (Appendix H - Option 5 Analysis)

4.4 Proposed Project Implementation and Phasing

The outlined treatment concept is suited for phased implementation, e.g. in 2 phases corresponding to the forecasted load in year 2025 respectively in year 2040.

Following the findings of the EIB FS Consultant allowing one year for design, tendering and contracting and two years for construction, the WWTPs could be **operational about mid of 2019**, whereas year 2040 gives 21 years of time horizon.

The implementation of the connecting transfer pipelines and the pumping stations are assumed to roughly follow the same schedule.

4.5 Outcomes of the Scoping (Options 1-4)

The Scoping Workshop for the Options 1-4 was executed at July 23, 2015 in the LWSC premises. Prior to the workshop an advertisement in Zambia Daily News was published on July 06, 2015.Furthermore, a total of 27 stakeholders has received a personal invitation letter (against signature).

Both documents the advertisement and the invitation list were attached as respective annexes to the Final Scoping Report.

Altogether 36 stakeholder were participating in the Scoping Workshop, plus 2 representatives of LWSC (PIU and Social Safeguard Managers), plus the ESIA Study TL and local expert. An introductory PowerPoint presentation on the Lusaka Sanitation Programme was held by the LWSC PIU Manager. This introduction was followed by the TL's PowerPoint presentation on the Lusaka Waste Water Project, focussing on the option analysis of 4 wastewater treatment facilities and the associated impacts. All participants received handouts of the full presentation.

During the following discussion many of the participants highlighted the project as major step in the City's development. At the same time, it was stressed that serious efforts are required to address the peoples mind in order to change their behaviour towards more responsibility on water and sanitation resources.

Topics being subject during the discussion (amongst others) were referring to:

- Involvement and role of ZEMA,
- Financing mechanisms and viability of the project,
- Availability of areas at Ngwerere Ponds,
- Offsite sanitation (further operation or closure of pit latrines in selected areas),
- Management and control of industrial polluter,
- How to address unacceptable sanitary conditions around the Garden Ponds?,
- Wastewater discharges of (cancer) hospitals into the sewer network,
- Impact (improvement) on groundwater quality as LWSC has to shut more and more wells due to quality problems (nitrate, E. coli).

Altogether 24 participants raised their concerns, views and/or suggestions. All comments were summarised in tabular form and attached as respective annex to the Final Scoping Report.

Given by the outcomes of the Scoping Workshop the following items are considered to be investigated in more detail:

- **Garden ponds:** Due to its poor physical conditions and missing safety arrangements, today the Garden Ponds are seen as most problematic risk to residents and the environment. Thus, each potential option and/or alternative related to Manchinchi WWTP will also have to refer to the Garden Ponds.

  One option might foresee the ponds still being part of the WWTP treatment process. In this case the ponds would have to be upgraded, secured and integrated into a systematic monitoring scheme.

  From the technological point of view, effluent disinfection could also be realised by other technical solutions (UV radiation, chlorination), which not necessarily would require the further operation of the ponds. In this case the ponds might be decommissioned, rehabili-

tated and made available for another type of usage. Hereby, it has to be kept in mind that the property is representing one of the most valuable assets of LWSC. On the other hand, experience from other sites shows that 'abandoned' areas will attract (illegal) settlement if not secured properly.

- **Fencing, site protection:** Today, all respective sites are accessible by neighbours due to missing fences and/or destroyed walls. In case of Manchinchi WWTP it is common practice that inhabitants cross the area even when protected by guards and/or regular police.

  Respectively, independently from the site that will be chosen as the 'preferred' option the remaining sites will require the re-establishment of a fence or wall including implementation of an effective security system.

  At Ngwerere ponds and Garden ponds, pedestrians and bicyclists use the narrow pathways between the ponds as if these would be public roads. This practice already led to drowning incidents, which could have been avoided if the respective site would have been securely fenced.

- **Public Health:** in the Zambian climatic conditions, open waters esp. if they are partially stagnant convert easily into breeding grounds for mosquitoes and other vectors, being a thread to the health of residents in the vicinity of the WWTP.

- **Addressing women and vulnerable groups**: having concluded the stakeholder analysis, the social impact assessment will focus more specifically on the involvement of women – both in the communities and in the associations such as the Zambia Alliance for Women, Zambia Women Farmers Union, and Zambia National Women's Lobby – just to name a few, in order to raise awareness on LWWP and the expected social and environmental impacts.

- **Continuous community education and sensitization**: representatives of the communities neighboring the WWTP admitted that they see the need for stronger and ongoing sensitization and education of residents in environmental issues, esp. solid waste management, and wastewater and sludge use for vegetable production.

4.6 Public Involvement and Consultations (Options 1-4)

As part of the ESIA process and in order to guarantee the participation of all concerned or affected parties public meetings were executed in close cooperation with the LWSC. In the following a compact overview is provided allowing the consideration of collected information and providing continuity during later phases of the ESIA process (Option 5 and/or ESIA studies in accordance with the ZEMA standard).

- one Public Consultation meeting during the Scoping Phase, 2015 as summarised in the chapter before;
- community meetings in each community nearby the concerned WWTP site; and
- individual meetings with the Ward Councilors of each concerned community.

4.6.1 Community Meetings

Respecting the fact that LWSC has established communication lines into the communities (regular consultations, customer service, grievance process) all community meetings were primarily organised and facilitated by the LWSC social safeguard officer.

Following the initial consultations with the Ward Councillors six respective topics were agreed on:

- List of problems / nuisances caused by WWTP
- Handling of solid waste in the community
- Handling of wastewater in the community
- Alternative locations for future WWTP
- Proposals for improvements at current WWTP
- List of opportunities from future WWTP implementation

The meetings took place according the following schedule:

- Ngwerere Ward (Manchinchi WWTP): Sept. 10, 2015; 40 participants (20 women, 20 men)
- Mwambeshi Ward (Chunga WWTP): Sept. 11, 2015; 27 participants (7 women, 20 men)
- Silvia Masebo Compound (Ngwerere ponds): Sept. 12, 2015; 64 participants (39 women, 25 men)

Data and information are presented in Chapter 5.4 'Socio-economic Environment'. The corresponding meeting protocols are presented in **Annex 4.**

4.6.2 Consultations with Ward Councilors

After an assessment and evaluation of the information collected during the community meetings, another set of meetings was scheduled with the Ward Councillors. The main purpose of the meetings was a) following up the respective community meeting, b) closing of information gaps, and c) addressing new topics not considered so far.

Such meeting was considered necessary only with the Ward Councillors of Ngwerere Ward (Manchinchi WWTP) and Mwambeshi Ward (Chunga WWTP). While information collected during the community meeting in Silvia Masebo Compound (Ngwerere ponds) was considered sufficient. For this purpose a questionnaire was prepared and filled in together with the Ward Councillor.

The consultations with the Ward Councillors were held on October 06 and 07, 2015. Collected data and information are presented in Chapter 5.4 'Socio-economic Environment'. The corresponding-Minutes of Meetings in form of filled in questionnaires are presented as **Annex 5.**

4.7 Stakeholder Engagement Plan

The Consultant prepared a Stakeholder Engagement Plan (SEP), providing information on the different stakeholders involved in the project and particularly in the ESIA process. The central purpose of the SEP is allowing the public to participate in and follow up all activities under the Lusaka Waste Water Project (LWWP). Hereto, the LWSC will have the responsibility of updating and implementing the SEP throughout the Project cycle.

The SEP was provided as attached document to the Draft ESIA Report submitted in November 2015.

5 DESCRIPTION OF THE SOCIAL, ENVIRONMENT, AND PUBLIC HEALTH STATUS QUO

This section describes the physical, biological and socio-economic baseline of the project. The spatial extent comprises the existing treatment environmental facilities, but also the surrounding settlements and communities.

5.1 Methodology

The following approach was used in the environmental and socio-economic baseline data collection and analysis presented in this ESIA, with the focus particularly on issues with expected impacts on key receptors.

General: The overall information collection process was primarily relying on secondary data sources, i.e. the exploitation of exiting data material. This refers to specialised studies (here desktop studies), but also data material acquired from different sources as indicated in the following Table 5-1.

While, with reference to field studies specialised environmental and socio-economic investigations were undertaken.

Environmental field studies: Biological flora and fauna audits at all WWTP sites were executed. At Manchinchi and Chunga WWTPs an ad-hoc flora / fauna inventory was executed on October 01, 2015. While, respecting the semi-natural structure surrounding the Ngwerere ponds an existing inventory assembled recently (Terra Tech. 2013) was taken as key reference. During several site visits this inventory was confirmed, and modified by own observations.

The EIB FS Consultant has conducted a set of associated field investigations along with the own data collection process during the period May to July 2015. Amongst others, qualitative monitoring programs included the quality and flows of receiving waters, effluent quality being discharged into these receptors and the quality of sewage sludge currently generated at all WWTPs. These data have been made available for the ESIA Study.

Socio-economic field studies: In order to collect relevant social data individual community meetings and individual meetings with the Ward Councillors in all communities surrounding the wastewater treatment facilities were executed. A brief summary of the methodology and findings was already introduced in Chapter 4.6 ‘Public Involvement and Consultations’.

Due to the scope and limited resources of this ESIA and with a variety of project options to be assessed, data collection could only go to a certain depth. Specialized, more detailed studies shall be part of the ESIA in accordance with the ZEMA Standard. Hereto, reference is made to Chapter 9 ‘Further Proceedings’.

Table 5-1: Data collection and main sources

Receptor	Data collection		Main sources
	primary (field surveys)	secondary (exisiting sources)	
Environmental receptors			
Surface water (effluent discharge)	no	yes	- LWSC laboratory records - COWI (2016) - Feasibility Study - Final (Appendix H - Option 5 Analysis) - COWI (2015a) - Flow Measurements & Sampling Report - COWI (2015b) - Option Analysis Report (on wastewater facilities)
Groundwater	no	yes	- LWSC laboratory records - Gauff (2013) - ESIA and ESMP for WATSAN Projects - existing studies
Soils	no	yes	- existing studies
Air quality / noise	yes	yes	- site visits - existing studies - interviews with community members / ward councillors
Smell	yes	yes	
Vector attraction	yes	yes	
Flora / Fauna	yes	yes	- inventory of flora and fauna species at all WWTP sites - existing studies
Social receptors			
Communities	yes	yes	- community meetings - semi-structured interviews - interviews with LWSC safeguard officers - official statistics (2010 census) - existing studies

5.2 Physical Environment

5.2.1 Topography

The City of Lusaka is characterised by a plain land surface with some isolated hilly areas. Located on the Central African Plateau, Lusaka has an average altitude of nearly 1,300 masl to the north, which is slightly higher than the surrounding areas, and gently slopes downwards about 100 m towards the east, south and west. Both the topology and morphology of the City of Lusaka is influenced by the underlying geological formation.

In general, the plateaus are located to the south and west of the City of Lusaka while flat-topped hills are to the north and east. The average elevation of the plateaus is 1,200 masl while the average elevation of the flat-topped hills is about 1,300 masl.

5.2.2 Geology

Lusaka comprises a pre-Cambrian basement complex consisting of granites, gneisses and quartzite which is overlaid by lime stones and dolomite rocks. Within greater depth the underlying rock formation shows a decreasing variation in fracturing intensity. The occurrence and layer stratification of the fractures have significantly dictated the groundwater flow in the Lusaka aquifer.

The structural setting of the lithographic units is subdivided by the long striking (WNW-ESE) “Lusaka Fault”. The Lusaka Fault steeply dips into a SWS orientation and separates the subsurface geology of the Lusaka area into a “Northern Domain” and a “Southern Domain”. The Northern Domain constitutes the early Proterozoic Basement Complex and is situated at relatively shallow depths while the Southern Domain characterizes the maximum thicknesses of the Katanga system meta-sediments (Gauff 2012).

The Northern Domain is bounded by the “Lusaka” and “Chelston” normal faults. The Early Precambrian basement is situated at comparably shallow depth, hence the meta-sediments of the Katanga system show reduced thickness. In the Southern Domain, a higher structural level is exposed reflecting thick-skinned (basement-involved) “fold-and thrust belt” tectonic. Here the early Proterozoic basement is situated in much higher depth, and the meta-sediments of the Katanga group reach maximum thickness.

Regionally, the Lusaka rocks are part of the Zambezi Belt and by definition is separated by the Mwembeshi Shear Zone, from the Lufilian Belth to the north. Specifically, the Lusaka area is covered by strongly folded over-thrusted meta-sedimentary rocks of Katanga (Neoproterozoic) age which have been introduced by granitic and basic bodies.

The Lusaka Dolomite Formation occurs as crystalline banded, grey and white dolomitc limestone. The hanging Cheta Formation (limestone and schists) reaches maximum thicknesses of 3.8 km in the southern domain. The Lusaka dolomite locally reaches thicknesses of up to 2.2 km south of Lusaka (Gauff 2012).

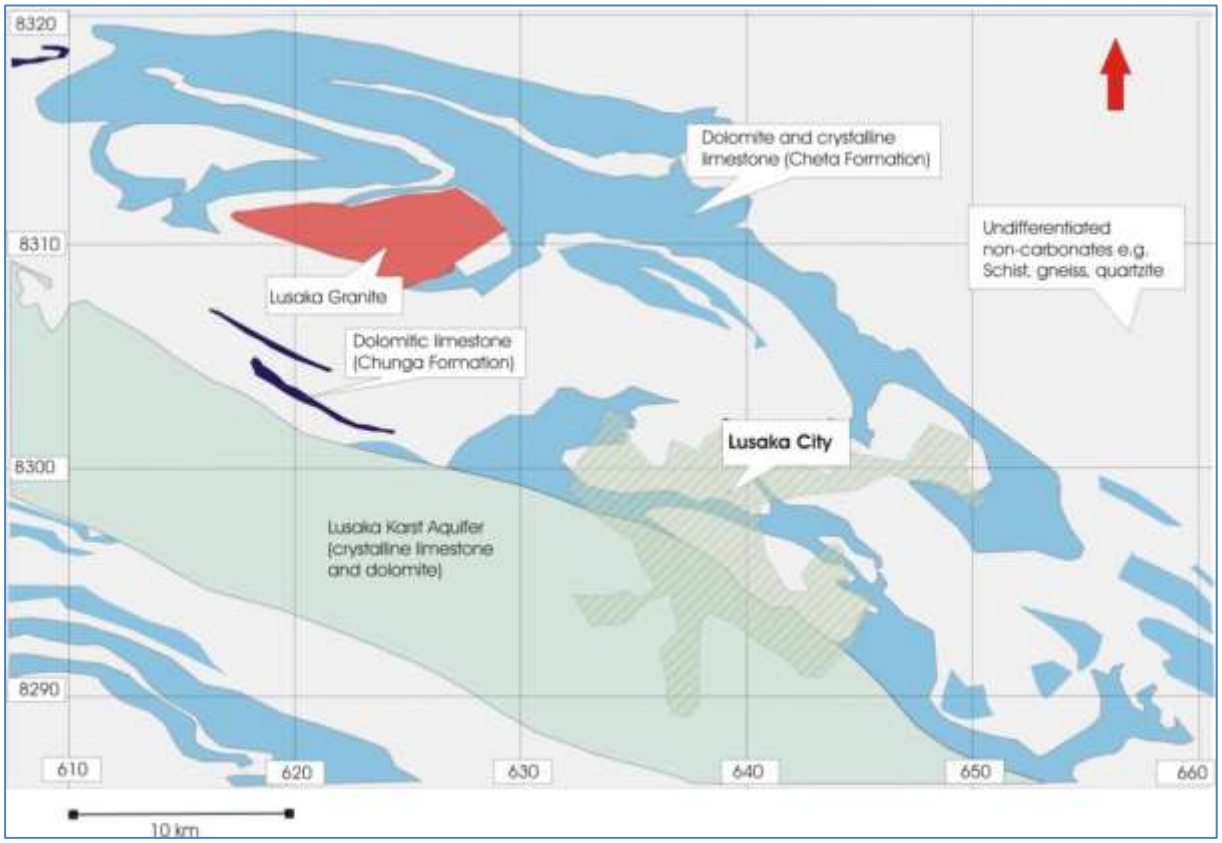


Figure 5-1: Lusaka geology

Source: Gauff (2012): Preparation of FS (30%) and Preliminary Design for Water and Sanitation Projects Lusaka

5.2.3 Soils

The soils (and vegetation) show a marked correspondence to the geological formations. Four distinct soil groups are recognized (Gauff 2012).

Specialised plateau soils: The Lusaka dolomite and parts of the calcareous horizons of the Cheta Formation are overlain by a variable thickness of pisolitic laterite with thin clayey or fine sandy soils often containing large numbers of laterite pisoliths. Where laterite reaches the surface it forms hard undurated pavements with little soil cover; south and west of Lusaka, dolomite outcrops over wide area.

Plateau soils: Immediately north of the Lusaka Dolomite outcrop and in the extreme northeast the fine sandy soils typical of the plateau are products of prolonged weathering of dominantly acenaceous rocks on a maturely eroded landscape.

Upper valley soils (i): South of the laterite soil zone there is a north-west trending belt of rich red-brown and dark brown loams of mixed colluvial origin.

Upper valley soils (ii): The soils underlying the gneisses, schists and quartzites of the Basement Complex are sandy loams. South-east of a line through Ngwerere and Chikumbi sidings there is a wide flat area of ill-drained swampy ground. The soils are thick and mixed colluvial and alluvial origin. Along the lower reaches of the Chunga River a broad, flat, alluvial plain supports valley or flood-plain grasslands.

5.2.4 Soil pollution

Manchinchi and Chunga WWTPs areas, due to its long term operation are expected to be polluted organic and inorganic substances. This statement especially refers to spots with a high contamination potential such as the drying beds, sludge lagoons, but also the area of the Garden ponds.

Another factor with reference to soil pollution is the safe application of effluent and sludge (soil conditioner, nutrients) for increased agricultural yields and income generation of farming families.

Unfortunately no qualitative and/or quantitative data could be acquired. The same fact also refers to the residential areas nearby the WWTPs.

In order to close this gap a specific investigation shall be attributed to the ESIA study to be prepared for the final option in accordance with ZEMA regulations.

5.2.5 Climate and Meteorology

5.2.5.1 Seasons

The general climate of Lusaka is characterised by a warm tropic savannah with three distinct seasons, namely: cold and dry; hot and dry season, and rainy seasons. The cold and dry season extends from April to mid-August while the hot and dry season covers the period of mid-August to mid-November, and the rainy season is from mid-November to mid-April. Rainy seasons are warm and wet and much of the rainfall is recorded between December and March.

5.2.5.2 Precipitation

Lusaka District receives an appreciable volume of rainfall, however almost exclusively during the rainy season. On average there is a total of 70 rain days per season. However, the monthly average number of rain days range from 6 to 15 days. The months of December, January and February receive over 70% of the rainfall in any given year as shown in Figure 5-2. In addition, long dry periods are also experienced.

In the rainy season from October to April, the monthly average rainfall is 114 mm, and the average annual rainfall over the past 30 years (period 1976/77 to 2005/06) was 802 mm (JICA 2009).

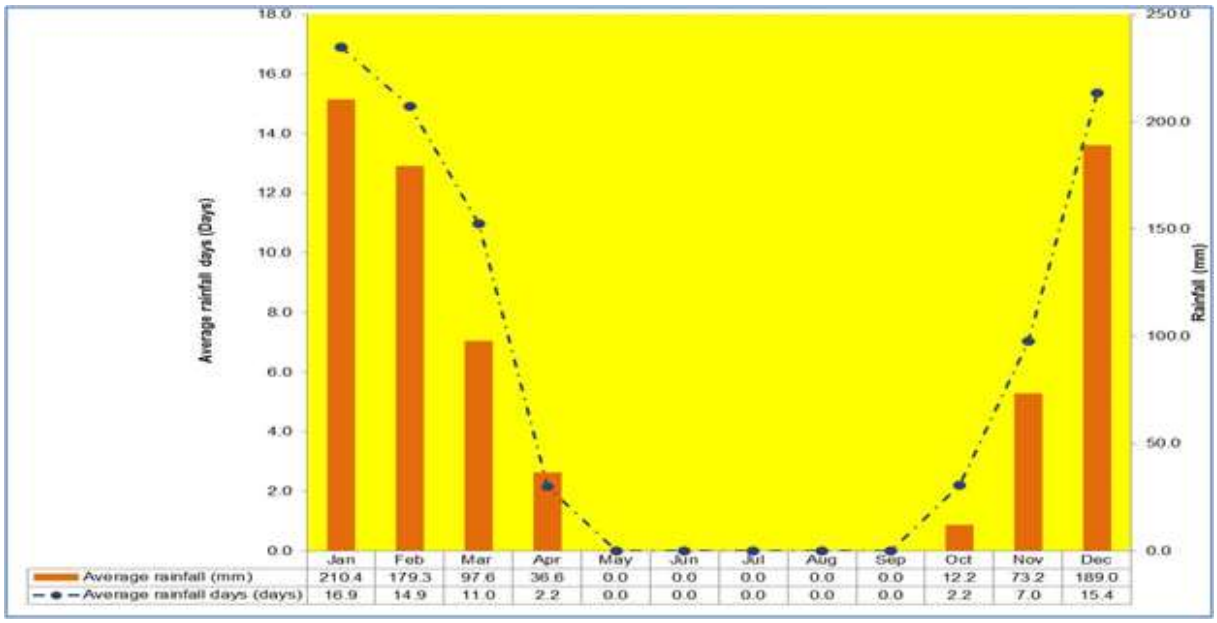


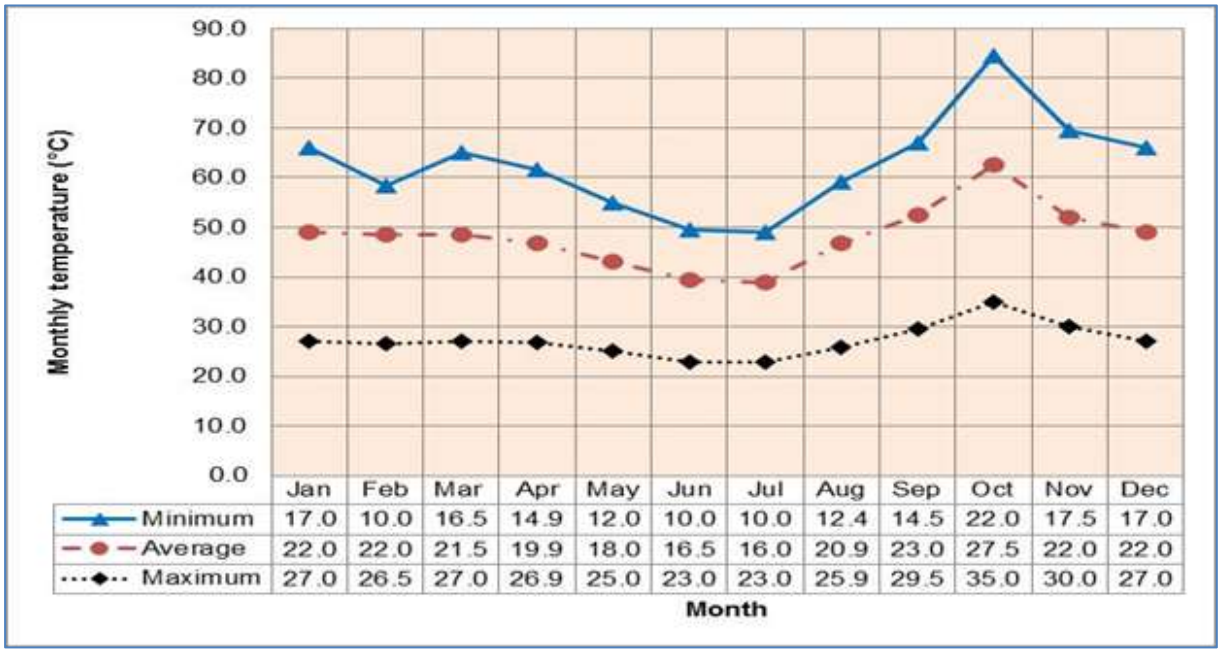
Figure 5-2: Monthly average rainfall and rainfall days in Lusaka

Source: JICA (2009): The Study on Comprehensive Urban Development Plan for the City of Lusaka

5.2.5.3 Temperature

Mean monthly temperatures for Lusaka District range from 14°C in the cold season to about 28°C in the hot season when humidity is comparatively high. Minimum temperatures which are as low as 9°C have been recorded in the month of July. While the coldest month of the year with temperatures of 30°C and above are recorded in October. Figure 5-3 shows the average maximum and minimum monthly temperatures for Lusaka District recorded for the period of 1976/77 to 2005/06.

Figure 5-3 indicates an average temperature throughout the year of 20.9°C. The average monthly maximum temperature reaches the highest of 35°C in October, and drops to a lowest of 10°C in July.



	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Minimum	17.0	10.0	16.5	14.9	12.0	10.0	10.0	12.4	14.5	22.0	17.5	17.0
Average	22.0	22.0	21.5	19.9	18.0	16.5	16.0	20.9	23.0	27.5	22.0	22.0
Maximum	27.0	26.5	27.0	26.9	25.0	23.0	23.0	25.9	29.5	35.0	30.0	27.0

Figure 5-3: Monthly temperatures in the City of Lusaka

Source: Zambian Meteorological Department (2006)

5.2.5.4 Wind

Lusaka District experiences prevailing eastern winds during the dry season with fresh winds in the months of July and August. During the months of December to April, light variable winds predominantly of northern and north-eastern directions prevail. Mean wind speed ranges from 1.1 m/s (4.0) to 2.5 m/s (9.0 km/h).

5.2.5.5 Evaporation and Humidity

The average annual evaporation for the City of Lusaka is around 2,070 mm, ranging from 104 mm in January to 315 mm in October. Humidity, on the other hand, averages 64% throughout the year. In general the humidity shows a decreasing trend from January to December. In January, during the peak of the rainy season, humidity rises, reaching 84% in January, then gradually reduces to a minimum monthly average of 45% in September (JICA 2009). Figure 5-4 gives the evaporation and humidity for the City of Lusaka.

Data presented in Figure 5-4 are based on short term periods. Evaporation data represent the period of the years 1989 to 2000, while humidity data cover the years 1988 to 1998 and 2005 to 2006.

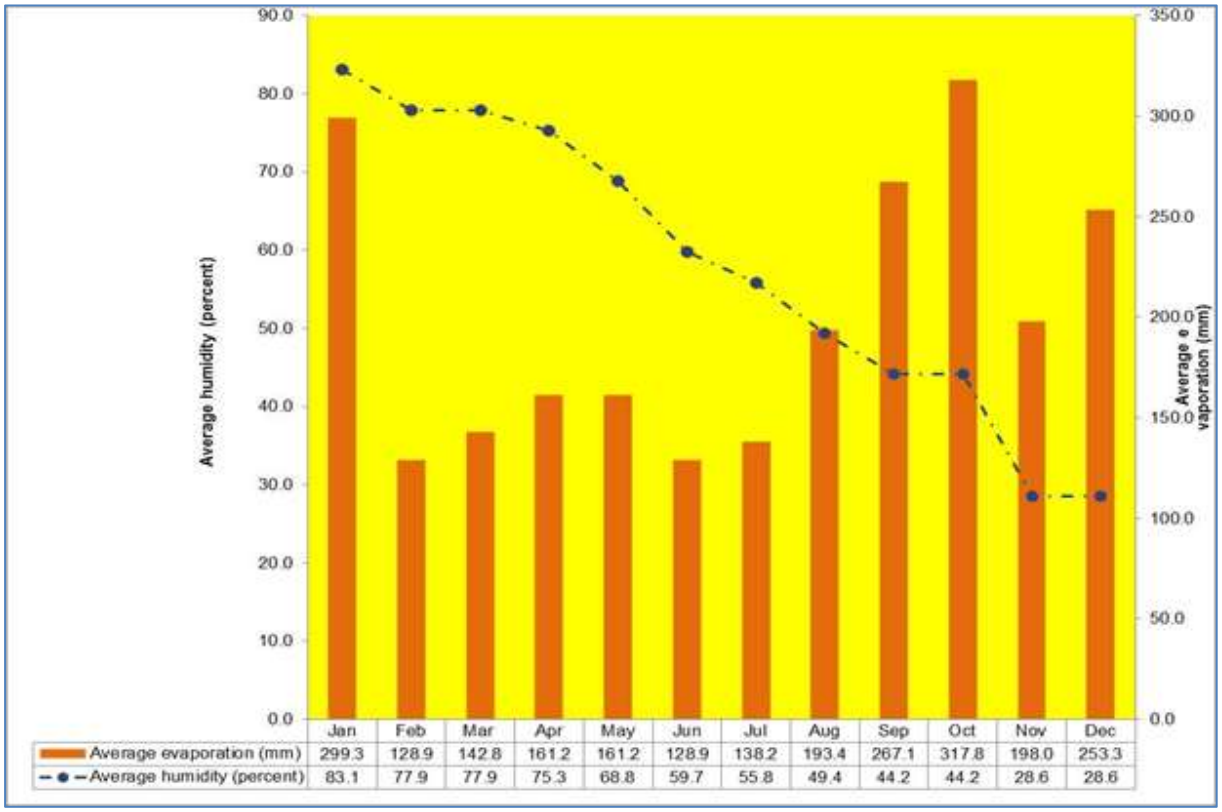


Figure 5-4: Monthly evaporation and humidity in the City of Lusaka

Source: Zambian Meteorological Department (2006)

5.2.6 Water Resources

5.2.6.1 Surface Waters

Lusaka is drained by a number of small watercourses, namely Chunga, Chalimbana and Ngwerere. The Chunga River and its tributaries flow westwards and then south into the Mwambeshi while the Ngwerere and Chalimbana Rivers flow north-east and east respectively to join the Chongwe River.

Key receptors: Referring to the surface waters key receptors are those receiving waters where the WWTP effluent is discharged. The following Table 5-2 is indicating the receiving water for each WWTPs and its further progress in the hydrographic system.

Table 5-2: Receiving waters for effluent discharges

Manchinchi WWTP (Garden Ponds)	Chunga WWTP	Ngwerere ponds
Garden River (tributary to the Ngwerere River)	Chunga River	Ngwerere tributary
Ngwerere River	Mwambeshi River	Ngwerere River

Manchinchi WWTP (Garden Ponds)	Chunga WWTP	Ngwerere ponds
Chlimbana River	Kafue River	Chlimbana River
Chongwe River		Chongwe River
Zambesi		Zambesi

River flows: In May / June 2015 a water and sludge quality monitoring campaign was undertaken as part of the key deliverables under the EIB FS. The findings and results are issued in the Draft Flow Measurement and Sampling Report (COWI 2015a).

River flow measurements of the receiving waters were undertaken in order to assess the dilution factor. Measurements were taken at outlet sites from the WWTPs. These measurements were carried out on June 16, 2015, the results, therefore, represent a dry season situation where dilution is lowest.

As shown in Table 5-3 the dilution factor is very small meaning that the flow in the rivers to a very high degree is effluent. In the case of Ngwerere River at the outlet from Ngwerere ponds, there are actual no recognisable flow upstream, meaning that the flow downstream is mostly effluent.

Table 5-3: River flows of WWTP receiving waters

WWTP	Receiving water	Upstream flow	Downstream flow	Calculated flow from WWTP	Dilution factor
		m^3/d			
Manchinchi Garden ponds	Garden River	12,179	19,122	6,943	2.8
Chunga	Chunga River	5,593	30,197	24,604	1.23
Ngwerere ponds	Ngwerere River tributary	0	4,624	4,624	1.0

Source: COWI (2015a): Flow Measurements and Sampling Report

Sampling date: June 16, 2015 (dry season > lowest dilution)

5.2.6.2 Surface Water Quality in WWTP Effluent Receiving Waters

Another central objective of the study was performing quality measurements at Manchinchi, Chunga WWTPs and Ngwerere ponds and the receiving waters. In order to allow an assessment of the WWTP discharges on the receiving waters the following sampling was undertaken: upstream / downstream of the WWTPs and the effluent quality.

The monitoring campaign has included selected parameters: pH value, Conductivity, BOD and COD, Nitrogen, Phosphorus and Chloride. No microbiological parameters were analysed. Upstream /

downstream measurement points were chosen at locations with accessibility to the respective river. While effluent samples of Manchinchi and Chunga WWTPs were taken at the outlet sites.

Manchinchi WWTP and Garden ponds

Effluent from the Manchinchi WWTP is inadequately treated as most of the units are not functional. However, some treatment is effected in the ponds, which receive the effluent from the conventional plant before it is finally discharged into the environment.

Despite the presence of the ponds, total COD still exceeded the regulatory limit for discharge into the environmental as stipulated by ZEMA. This is also the case for Ammonia what can be attributed to the imperfect treatment process.

In terms of COD and BOD, downstream results were significantly higher than the effluent. This means in this case, the effluent is not diluting the water in the river as indicated in the Table 5-4.

Table 5-4: Water quality results of Manchinchi WWTP and Garden River

Parameter	Unit	Upstream	Effluent	Downstream	Permissible limit
pH	-	7.49	7.4	7.48	6-9
COD	mg/l	166	147	297	90
BOD		40	34	130	50
Conductivity	µS/cm	968	1,005	996	4,300
Ammonia (as NH_4-N)	mg/l	5.23	33.07	0.23	10
Nitrites (as NO_2–N)		0.003	0.011	0.006	2
Nitrates (as NO_3–N)		<0.01	1.34	<0.01	50
Total phosphates		<0.01	0.56	0.02	6
Chlorides		58	78	54	800

COWI Limited (2015a): Flow Measurement and Sampling Report

Sampling date: June 15, 2015

Chunga WWTP

Effluent from the plant is inadequately treated as most of the units are not operational. This is evident from parameters measured like BOD, COD, and Phosphorus which exceeded the regulatory limit for discharge into the environment as stipulated by ZEMA. In case of Ammonia, there is already a significant pre-load in the upstream flow. Altogether the quality monitoring results underline the industrial character of the wastewater being treated at Chunga WWTP.

As shown in the Table 5-5 after discharge of the effluent into the river the organic load (BOD) is increasing. This fact is difficult to interpret as the opposite was expected.

Table 5-5: Water quality results of Chunga WWTP and Chunga River

Parameter	Unit	Upstream	Effluent	Downstream	Permissible limit
pH	-	7.58	7.14	7.22	6-9
COD	mg/l	384	3200	2400	90
BOD		14	120	250	50
Conductivity	µS/cm	1,224	1,857	1,775	4,300
Ammonia (as NH_4-N)	mg/l	12.05	35.05	28.38	10
Nitrites (as NO_2–N)		0.011	0.007	0.01	2
Nitrates (as NO_3–N)		<0.01	<0.01	<0.01	50
Total phosphates		0.26	12.27	6.79	6
Chlorides		105	196	171	800

COWI Limited (2015a): Flow Measurement and Sampling Report

Sampling date: June 15, 2015

Ngwerere Sewage Ponds

Ngwerere ponds employ stabilisation ponds for the treatment of the wastewater. At the time of sampling, there was no upstream flow as the stream had dried up. This means that the effluent and the downstream samples are expected to be almost the same. The fact that the distance between the two sampling points (for the effluent and the downstream samples) was small (less than 50m) makes it even more rational to assume that the effluent and downstream samples are almost the same although minor differences could be expected due to a bit of dilution from groundwater. However, this assertion is not supported by the laboratory results.

Table 5-6: Water quality results of Ngwerere ponds and Ngwerere River

Parameter	Unit	Upstream	Effluent	Downstream	Permissible limit
pH	-	7.24	8.45	7.81	6-9
COD	mg/l	208	358	164	90
BOD		90	40	4	50
Conductivity	µS/cm	952	686	879	4,300
Ammonia (as NH_4-N)	mg/l	5.48	<0.01	2.15	10
Nitrites (as NO_2–N)		0.003	0.01	0.008	2
Nitrates (as NO_3–N)		<0.01	<0.01	<0.01	50

Parameter	Unit	Upstream	Effluent	Downstream	Permissible limit
Total phosphates		<0.01	<0.01	<0.01	6
Chlorides		75	82	81	800

COWI Limited (2015a): Flow Measurement and Sampling Report

Sampling date: June 15, 2015

5.2.6.3 Groundwater

The dolomitic limestone underlying most of the city constitutes a karstic aquifer of both local and regional importance. A total of 130,000 m^3 per day is abstracted from groundwater in Lusaka. On average, the production boreholes of the LWSC are 50 m deep. The general groundwater trend in Lusaka is to decrease in the dry season and recover during the rainy season. The fluctuations of the water table, though at different levels, remain moderate, seldom exceeding 5 m (Gauff 2013), and these fluctuations reflect the general behaviour of groundwater during times of recharge and discharge.

The volume of the productive aquifer in Lusaka has been calculated at 12 km^3, with recharge values ranging from 37 to 775 mm, i.e. from 5% to 95% of the annual rainfall (Gauff 2013). Groundwater recharge is directly through sinkholes while in areas of outcropping karst, all the rainwater seeps into the underground.

Groundwater quality of deeper aquifers in the City of Lusaka is generally good and conforms with to the WHO guidelines for drinking water. While, groundwater sample analysis from shallow aquifers often shows elevated concentrations of nitrates as well as positive count for microbiological indicator. Table 5-7 gives groundwater chemistry analysis of selected parameters (Gauff 2013).

Table 5-7: Water quality of selected boreholes. Marked boreholes are located in the project area.

Name of borehole	Parameter								
	pH	Temperature	Conductivity	TDS	Nitrates (as NO_3-N)	Nitrates (as NO_2-N)	Ammonia (as NH_4-N)	Total phosphates	Faecal Coliforms
		°C	mMhos/cm	mg/l					#/100 ml
Libala Water BH	6.32	25.8	636	318	9.34	0.003	<0.01	-	13
Leopards Hill BH	6.55	25.4	663	332	4.94	<0.001	<0.01	-	20
Chilenje South BH	6.81	24.7	626	312	9.86	0.001	<0.01	-	34
Lake Road BH	6.96	25.2	632	312	3.52	<0.001	<0.01	-	0

Name of borehole	Parameter								
Mass Media BH5	6.62	24.8	766	383	11.70	<0.001	<0.01	-	TNTC
Nissir 1 BH	7.04	24.8	659	329	0.18	<0.001	0.03	-	7
George Machinery Hse No.6	7.10	25.7	582	292	4.38	0.016	<0.01	0.04	0
George Machinery Hse No.2	6.77	25.8	657	327	5.31	0.006	0.06	<0.01	0
Chelstone BH No.3	7.19	22.3	673	336	5.22	<0.001	0.05	<0.01	0
Chunga BH	6.60	25.4	1054	527	15.75	<0.001	0.11	<0.01	0
New Avondale BH	7.10	24.7	700	350	3.88	0.001	0.04	<0.01	0
Chainda BH	6.96	24.9	1130	560	39.50	0.003	0.28	<0.01	7
Chunga BH1	6.80	24.9	1105	552	19.68	<0.001	0.05	0.04	0
International 6A BH	6.77	25.2	707	347	3.61	<0.001	0.04	<0.01	0
Malo Farm GER	7.23	24.4	685	341	2.09	<0.001	0.01	<0.01	0
Roadside BH01	7.06	25.4	687	343	10.70	<0.001	0.03	<0.01	0
Mulungushi 6H BH	6.72	25.2	771	389	1.38	<0.001	0.03	<0.01	TNTC
Garden DFT BH	6.84	24.8	846	416	7.77	0.014	0.02	<0.01	0
Lilayi 1C BH	6.77	25.7	595	298	0.53	0.001	0.02	<0.01	0
Shaft V BH	6.75	25.0	609	304	0.43	0.003	<0.01	<0.01	0
Chawama BH No.2	6.57	25.3	136	684	23.90	0.019	0.04	<0.01	0
WHO Drinking Water Guidelines	**6.5-8.5**	**-**	**1500**	**1000**	**10**	**0.6**	**1.5**	**1.5**	**0**

Source: Gauff (2013): Lusaka Water Supply, Sanitation and Drainage (LWSSD) Project: Detailed Engineering Design, Tender Documents, Detailed ESIA and ESMPs for Water Supply and Sanitation Projects

With reference to the boreholes and the respective groundwater quality in the project area there are implications that the WWTP effluent, at least indirectly, contributes to the pollution of the groundwater. This specifically refers to the parameter Nitrate (NO_3).

In Chunga borehole and Chunga borehole 1, Nitrate concentrations of 15.75 and 19.68 mg/l were recorded, hereby exceeding significantly the WHO Drinking Water Standard outlined to be 10 mg/l. At the same time high concentrations of Ammonia (NH_4) are transferred into the Chunga River as result of the imperfect wastewater treatment of the Chunga WWTP.

The same observation can be made for Manchinchi WWTP / Garden ponds, even when the Garden DFT borehole in terms of the parameter Nitrate has not exceeded yet the concentration as imposed by the WHO for drinking water.

River beds, as far as not clogged, are outside the rain season the main source for groundwater recharge in shallow aquifers. While river water is infiltrating into the ground a significant treatment of the water based on biological, physical and chemical processes is taking place, especially in the

(oxygenated) layers close to the surface. The next Figure 5-5 is providing an overview of the Lusaka aquifer system.

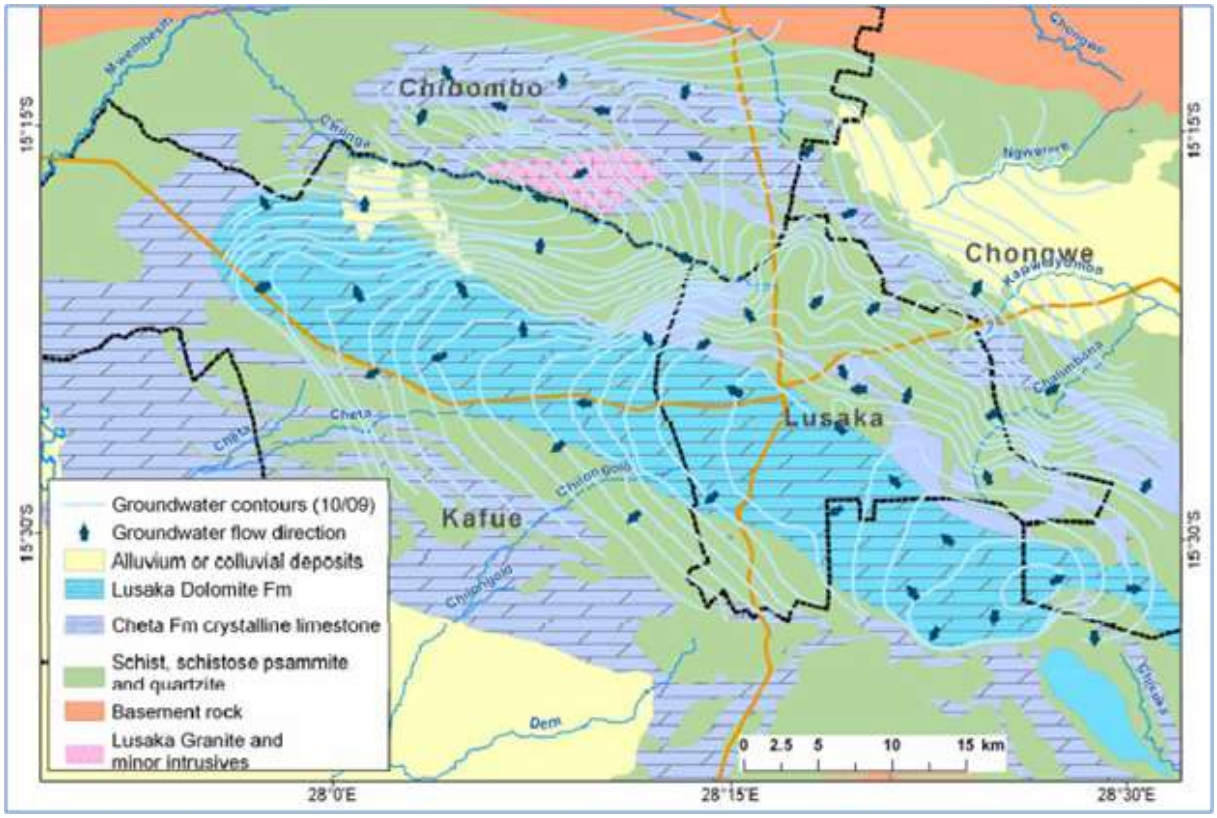


Figure 5-5: Lusaka groundwater aquifers and flow direction

Source: German Federal Institute for Geosciences and Natural Resources (BGR), undated

5.2.7 Flood Areas

Floods are experienced in some parts of Lusaka every rainy season and these occur mainly in the months of January and February during the peak period of the rain season. Nonetheless, inundations also occur in December. JICA (2009) documented the floods that occurred in Lusaka between October 2007 and February 2008, affecting a total of 21 sites, 15 of which were flooded by the second week of December. The majority of these areas were located in the western, north-western and southwestern parts the City. Furthermore, JICA (2009) identified a total of 11 frequently flooded areas in Lusaka and these included among others:

- Kanyama; almost the entire compound;
- Soweto Market area; mainly along access road;
- Kalikiliki; almost the entire compound;
- Chazanga-Kabanana; most part of compounds;

- George; some area mainly roads;
- Garden; some area including Chilulu and Luangwa compounds;
- Northmead; along Manchinchi Road near Northmead Basic School;
- Kabwata township;
- Kamwala township;
- Kamwala South, and
- Misisi compound.

Manchinchi WWTP: During the community meeting held at September 10, 2015, participants claimed that flooding is a major problem especially during the rainy season. As many drains are blocked by solid waste the water cannot run off flows into their compounds and houses or forms stagnant water pitches. It was claimed that these stagnant water attracts vectors such as mosquitos. It has to be stated that the findings of the community meeting have confirmed information collected earlier during initial site visits at Manchinchi WWTP.

Chunga WWTP: Flooding does not represent a problem for the community living around Chunga WWTP. So far, during community meetings and site visits no respective information was received. This might be caused by the sloped area of the WWTP site which directly drains run off water and/or mixed wastewater directly into the Chunga River.

Ngwerere ponds: During the community meeting held at September 12, 2015, participants claimed that flooding is a major problem especially during the rainy season. As ponds are not sealed (any-more), wastewater from ponds contaminates the shallow wells (3 dug wells, about 6 m deep). The problem is evident as in general the community area (Silvia Masebo Compound) is water logged, and after rains the temporary pit latrines are overflowing.

5.2.8 Air Quality

Air quality in the City of Lusaka is influenced by anthropogenic activities. Two main sources are distinguished, namely mobile and stationary sources. Industrial activities are a major source of ambi-ent air pollution arising from stationary sources while motor vehicles account for majority of the air pollution emissions from mobile sources.

The majority of industries are located in the western part of the City. Emissions to the ambient air from industries are mainly from boilers, particularly coal, wood and diesel fired boilers. Typical air pollutants from boilers include particulate matter (PM), Carbon monoxide (CO), Carbon dioxide (CO_2), Nitrous oxide (NO_x) as well as Sulphur oxide (SO_x).

In addition, illegal quarrying also contributes to localized air pollution. Open air burning of motor vehicle tires is common at these quarries. The tires are burnt at these quarries as a way of weakening the rock matrix, and thereby making the rock easy to break. Other sources of localized ambient air pollution are the use of charcoal and firewood for cooking. Prolonged exposure to these activities risks acute respiratory infections (ARIs). Combustible fuels are a source of PM, CO, CO_2, NO_x, SO_x and hydrocarbons.

Similarly, main pollutants from exhaust emissions from motor vehicles include Hydrocarbon and Benzopyrene, Phosphorus, Carbon monoxide, Sulphur oxides and Nitrous oxide. Exhaust emissions are highest in the Central Business District (CBD) and on major roads such as highways and the roads from townships into the CBD, and varies according to periods of peak traffic flow.

Nonetheless, the air quality is not a major environmental hazard in the City of Lusaka but increase in industries coupled with the rampant use of charcoal and fuelwood at household level may heightened the risks of ARIs.

With reference to the three project sites the air quality, here referred as smell, is representing a significant problem.

Manchinchi WWTP including Garden Ponds: During the community meeting held at September 10, 2015, participants reported that when the WWTP was still operating, there was no smell and less mosquitos. Also the Garden ponds were stated to have been in much better condition. Nowadays, smell nuisance has its highest intensity especially in the morning and in the evening hours.

On the other hand wastewater generated in the community is disposed off just on the road, sometimes in the newly build drains which also receive a lot of solid waste. Another source for smell generation are the pit latrines.

Chunga WWTP: During the community meeting held at September 11, 2015, participants reported that when residents moved in the community in 1974 the WWTP was well functioning and there was no smell and no mosquitos; the houses were connected to the WWTP and they had reliable water supply to flush the toilets. Since years, the WWTP is not maintained and is emitting smell at any time.

Nowadays, foul smell of different intensity is experienced by the entire community during day and night.

Ngwerere Ponds: During the community meeting held at September 12, 2015, participants claimed that smell is a major problem especially during the rainy season. It was reported that there is often a foul smell emanating from the ponds and affecting the community.

On the other hand it was also stated that wastewater is disposed in the garbage pits. Generation of smell might be also attributed to the fact that the community area (Silvia Masebo Compound) is water logged, and after rains the temporary pit latrines are overflowing.

5.2.9 Noise and Vibration

Most of the City of Lusaka experiences 'typical' noise and vibration levels which are generated from normal human activities and motor vehicles (Gauff 2013). Noise and vibrations from the industrial area are considered to be comparatively low given the small amount of industrial activities present. Nonetheless, road traffic noise levels especially along the heavy trafficked roads in the City are within the 75 to 80 dB(A), the range of densely travelled roads as established by the WHO study of 1999 (Gauff 2013).

Unfortunately no qualitative and/or quantitative data indicating the noise potential around the WWTP sites are available. Given this fact relevant information have been collected during site visits and community meetings.

Manchinchi and Chunga WWTPs

Today both WWTPs are surrounded by medium or densely populated settlements characterized by small-scale business activities. Here, the 'typical' noise level originates from daily business activities and traffic.

On the other hand, technologically both WWTPs are practically not operational. Most of the technical and electrical installations are out of service. This situation goes along with a low noise level that is not representative for WWTPs of this size and the installed treatment technology. Also, due to the fact that both WWTP were implemented applying trickling filters, no high noise level installations (generators, blowers) ever existed.

In fact, during interviews and community meetings noise was identified as insignificant amongst factors having a negative impact on the daily life.

Ngwerere Ponds

Ngwerere ponds are implemented as gravity-based system comprising of four ponds. No mechanical or electrical installations do exist; respectively noise is considered as insignificant.

5.2.10 Climate Change Projection

The climate of Zambia, including its precipitation and temperature patterns, is expected to continue to change in the next 5 to 40 years. In the absence of adaptation strategies or disaster risk management, this could affect the agriculture, health, and energy sectors, but also infrastructure projects.

A report recently published by the Climate Centre Project (2015) synthesizes current published information regarding climatology, climate variability, and near-term climate change in Zambia. Country, regional, and climate studies have been integrated into a comprehensive picture of Zambia's current and near-future climate.

Climate change is likely to may affect the sustainability of the planned infrastructure investment. For the project, the main climate induced effects to consider are (1) rising temperatures, (2) heavy rainfall and flooding, (3) drought and water scarcity as well as (4) heavy storms.

Historical climate in Zambia

Rising temperatures: Historical trends indicate that the mean annual temperature has increased by 1.3°C since 1960 and average rainfall by 1.9 mm/month, with shorter and more intense rainy seasons. As a result, a rise in the number and frequency of floods and droughts has been recorded, as well as the areas affected (GRZ 2011).

Variable precipitation: Rainfall averages about 960 mm annually, but is variable across the Zambezi river basin, from 1,500mm annually in the northern highlands to 600 mm in the south-west (Beilfuss 2012). The past 40 years has seen a slight reduction in annual precipitation, along with increased variability in rainfall year-to-year, and an increase in extreme precipitation events.

Floods and droughts: Historically, Zambia has been prone to extreme rainfall events resulting in widespread flooding. A recent flooding event during the 2006–7 rainy season saw nearly 1.5 million people affected (GRZ 2007). Amongst others, typical impacts from a major flooding event included collapsed houses and buildings, destruction of infrastructure (roads, sanitation facilities), contaminated water supplies and an increase in human diseases.

Zambia generates over 90% of its power from hydroelectricity, making energy security highly dependent upon precipitation patterns. Reduced power generation in recent years has had a negative impact on the economic productivity as this leads to increased power shortages, forcing industries to reduce their levels of production.

Future climate in Zambia

Due to the limited availability of relevant data the future prediction of climate change effects is linked with significant uncertainty. This statement especially refers to regional climate models.

Rising temperatures: In coming decades, the temperature across Zambia, along with the entire southern African region, is widely expected to increase (e.g. Christensen et al. 2013), and probably at a faster rate than the global average for all seasons. For Zambia, until the end of the century a warming in the range of 2.4 to 4.3°C (compared to the reference period from 1961 to 1990) is likely. Furthermore, a strong increase in the duration of heat waves is projected (CSC 2013).

Increased annual variability: The increasing variability in Zambian rainfall throughout the 20th century is notable and related to more spatially widespread and intense droughts associated with El Niño (Fauchereau et al. 2003). The connection between El Niño/La Niña and Zambian rainfall has been increasing in strength over time (Fauchereau et al. 2003; Christensen et al. 2013). It is indicated that this has led to increasing drought potential and wet spells in both severity and extent.

While, according to CSC (2013) climate models do not project a clear trend in precipitation amounts. For the end of the century a change in annual total precipitation in the range of -6 to +5 percent (compared to the reference period from 1961 to 1990) is likely. Furthermore, projections suggest a tendency towards more intense and more frequently heavy rainfall events as well as a substantial elongation of dry spells.

5.3 Biological Environment

The assessment of flora and fauna focused on the proposed WWTP sites and their immediate surroundings. These were assessed by secondary data collection, ad-hoc inventories and observations made during site visits. Interviews were conducted with both locals and WWTP operational staff. Secondary data was collected through the use relevant literature i.e. environmental assessments executed recently.

5.3.1 Manchinchi and Chunga WWTPs

Flora: Generally, both WWTPs including the Garden Ponds are located in urban built up areas; therefore, there is very low biodiversity. An ad-hoc flora inventory was executed at on October 01, 2015 at both sites. Flora at Manchinchi WWTP consists of few fruit tree and ornamental species such as Mango (*Mangifera indica*) and Jacaranda (*Jacaranda mimosifolia*) in combination with some native shrubs. The vegetation cover indicates a highly disturbed habitat. While, Chunga site is characterized by shrubs and/or thickets, but with less variability. A list with all recorded species is presented hereafter as Table 5-8.

Small areas around the Garden Ponds are used by the inhabitants of the nearby settlement to cultivate vegetables such as cabbage, tomatoes and onions.

Table 5-8: Flora inventory of Manchinchi and Chunga WWTPs

Species	Manchinchi WWTP Garden Ponds	Chunga WWTP
Trees		
Mangifera indica	X	-
Jacaranda mimosifolia	X	-
Shrubs / thickets / herbs		
Acacia polyacantha	X	X
Brachystegia boemhii	X	X
Acacia tortilis	X	X

Species	Manchinchi WWTP Garden Ponds	Chunga WWTP
Dichrostachys cinerea	X	X
Bidens pilosa	X	-
Phyllanthus leucanthus	-	X
Datura stramonium	-	X
Polygonum persicaria	X	-
Tithonia longifolia	-	X
Sambucus spp.	-	X
Grasses		
Hypperrhenia spp.	X	X
Andropogon spp.	X	X
Cyperus esculentus	-	X
Eragrostis aspera	-	X
Phragmites australis	X	-

Source: CES, date of inventory: October 01, 2015

Fauna: The following species as listed in the next Table 5-9 were encountered. The dominating fauna group being recorded at the WWTP sites were insects. This finding might be explained with the fact that many insects have a water-borne development cycle (larvae stage). Altogether, the recorded species and higher fauna groups are common.

Table 5-9: Fauna inventory of Manchinchi and Chunga WWTPs

Species	Manchinchi WWTP Garden Ponds	Chunga WWTP
Reptiles		
Ichnotropis squamulosa (Common rough-scaled lizard)	X	X
Insects		
Ants (black and red)	X	X
Arachnidae (spiders)		X
Coleoptera (beetles)	X	X
Caelifera (grasshoppers)	X	X
Culicidae (mosquitos)	X	X
Hymenoptera		X

Species	Manchinchi WWTP Garden Ponds	Chunga WWTP
Musca domestica	X	X
Nymphalidae (butterflies)	X	X
Odonata (dragonflies)	X	

Source: CES, date of inventory: October 01, 2015

5.3.2 Ngwerere Ponds

Similar to Manchinchi and Chunga WWTPs an inventory of the flora / fauna was also assembled for the area surrounding Ngwerere ponds. Hereto an existing inventory assembled recently (Terra Tech. 2013) was taken as key reference. During several site visits this inventory was confirmed, and modified by own observations.

Due to the partly semi-natural habitat structure both flora and fauna around the pond system was found to be more diverse as in the urban city center. Nevertheless, the flora and fauna showed a pattern typical for rural and semi-rural habitats. The next Table 5-10 and Table 5-11 summarize the findings of the flora / fauna inventory.

Table 5-10: Flora inventory of Ngwerere area

Species	
Trees/shrubs	
Acacia cyclops	*Persea americana*
Cassia abbreviate	*Piliostigma thonningii*
Combretum spp.	*Poncirus trifoliata*
Dilonix spp.	*Psidium guajava*
Eucalyptus spp.	*Rhoicissus tomentosa*
Jacaranda mimosifolia	*Rhus longipes*
Lantana camara	*Salix subserrata*
Mangifera indica	*Sesbania punicea*
Parinari curatellifolia	*Tamarindus indica*
Herbaceous plants	
Acalypha crenata	*Euphorbia hirta*
Acanthospermum hispidum	*Galinsonga parviflora*
Achyranthes aspera	*Ipomoea dichroa*
Ageratum conyzoides	*Leucas martinicensis*
Amaranthus hybridus	*Nicandra physalodes*
Amaranthus spinosus	*Oldenlandia herbacea*
Bidens pilosa	*Portulaca oleracea*
Bidens schemperi	*Phyllanthus leucanthus*

Species	
Cassia obtusifolia	*Senecio abyssinicus*
Cassia spp.	*Sida alba*
Celosia trigyna	*Trichodesma zeylanicum*
Conyza sumatrensis	*Tridax procumbens*
Crassocephalum rubens	*Triumfetta annua*
Grasses	
Andropogon spp.	*Echinochloa colona*
Cyperus esculentus (sedge)	*Eleusine indica*
Cynodon dactylon	*Eragrostis aspera*
Cyperus spp.	*Hyparrhenia spp.*
Dactyloctenium aegyptium	*Setaria homonyma*
Digitaria milanjiana	*Setaria pumila*
	Typha spp.

Source: Terra Tech. (2013): ESIA for Sanitation: Scoping Report. - Modified and adapted by CES (2015)

Table 5-11: Fauna inventory of Ngwerere area

Species	
Birds	
Anas platyrhynchos	*Passer domesticus*
Cisticola juncidis	*Passer griseus*
Corvus albus	*Prinia subflava*
Hirundo senegalensis	*Pycnonotus barbatus*
Lanius collaris	*Tchagra senegala*
Lonchura cucullata	*Uraeginthus angolensis*
Reptiles	
Chamaeleo calyptratus	*Varanus Indicus*
Hemidactylus mabouia	*Zootoca vivipara*
Ichnotropis squamulosa	
Amphibia	
Phrynobatrachus natalensis	*Xenopus laevis pertersii*
Insects	
Ants (black and red)	*Musca domestica*
Aeshnidae (dragonflies)	*Nymphalidae* (butterflies)
Coleoptera (beetles)	*Palystes castaneus*
Caelifera (grasshoppers)	*Termitidae*
Hymenoptera	

Source: Terra Tech. (2013): ESIA for Sanitation: Scoping Report. - Modified and adapted by CES (2015)

5.3.3 Final Assessment

Considering the biological environment the flora / fauna inventories at all potential WWTP sites can be summarised as follows:

- No threatened, rare or endangered species of fauna or flora were registered or known to exist around the WWTP sites.
- No sensitive or fragile habitats were noted in relation to the extent and magnitude of the envisaged works.
- No species of fauna or flora that could be exploited for commercial purposes have noted in proximity to the proposed works.
- The current degree and extent of the proposed works do not interfere with any protected area.

5.4 Socio-economic Environment

Information on the socio-economic environment is presented with reference to a higher community level (district, province) in order to provide a general overview. This information is then, as far as available, backed up with data at project area level. Hereto, community meetings were held on September 10-12, 2015 at each individual project location. The collected information was assessed by the ESIA team and subsequent verification interviews were conducted with the responsible ward councillors on October 06-07, 2015.

Communities potentially affected by the project implementation are:

- Manchinchi WWTP: Ngwerere Ward including Chilulu, Garden and Luangwa compounds; Kapwayambale Ward,
- Chunga WWTP: Mwembeshi Ward, and
- Ngwerere ponds: Silvia Masebo Compound (formerly known as Ngwerere ward).

The comprehensive information protocols (questionnaires) are saved as **Annex 4**. Here reference is made to relevant socio-economic parameters, population density, infrastructure and health issues in the communities neighbouring the current WWTPs.

5.4.1 Population Development

The City of Lusaka covers an area of 360 km² (the total municipal area is approximately 423 km²). The seven constituencies forming Lusaka are: Lusaka Central, Kabwata, Kanyama, Matero, Mandevu, Munali and Chawama.

About 80% of Lusaka's population lives in the 37 unplanned peri-urban areas (PUAs), which are making up 20% of the city's residential land (WB 2002) and occupy only 10% of the total area of the City of Lusaka. PUAs are located predominantly to the north, northwest and south of the Central Business District (CBD). Although the average population density for Lusaka District is 150 persons

per hectare, this varies considerably from 5 persons per ha in upmarket areas to almost 1,450 persons per ha in PUAs (LCC and ECZ 2008).

The City's population of 1,742,979 comprises 854,060 male and 888,919 female persons, representing 49% and 51%, respectively (CSO 2011). Lusaka's population accounts for 32% of the total urban population in Zambia and has been growing at an average rate of 3.7% per annum from 1980 to 2010. The population is predominately young, with up to 70% of the population estimated to be below the age of 30.

5.4.2 Population in the Project Communities

In the communities affected by the project - Kapwayambale Ward, Mwembeshi Ward and Silvia Masebo Compound (formerly known as Ngwerere ward) – the percentage between male and female residents is similarly balanced as in Lusaka in general.

Table 5-12: Population statistics by gender and age for the project areas

Age group	Kapwayambale Ward		Mwambeshi Ward		Silvia Masebo Compound	
	Male	Female	Male	Female	Male	Female
0-4	1,551	1,615	5,095	5,088	4,847	4,867
5-9	1,217	1,298	4,309	4,528	4,056	4,138
10-14	1,081	1,143	4,46	4,756	3,821	4,338
15-19	826	949	4,027	4,524	3,533	4,09
20-24	739	925	3,245	3,89	3,38	3,921
25-29	839	846	3,081	3,491	3,716	3,659
30-34	735	653	2,911	2,736	2,977	2,777
35-39	650	471	2,576	1,959	2,453	1,845
40-44	446	273	1,676	1,139	1,441	1,115
45-49	270	186	1,084	916	911	764
50-54	193	109	696	578	586	649
55-59	86	69	455	332	431	402
60-64	79	49	282	262	362	299
Above 65	85	82	362	420	397	430
Total	**8,797**	**8,668**	**34,259**	**34,619**	**32,911**	**33,294**

Source: CSO (2013a): 2010 Census of Population and Housing: Descriptive Tables, Series A, B, C and D, Lusaka Province, Central Statistics Office, Lusaka

Looking at the most vulnerable group in the communities, the orphaned children, CSO in 2013 published the following data, which reveal that a relevant part of the population in the affected communities is highly vulnerable. Given the fact that the majority of the orphans lost their fathers, the poor

economy of the female or children headed households is a great challenge for the community development.

Table 5-13: Orphaned children

Ward	Age group	Orphans				Percentage of orphans within age group	Percentage of orphans in total population
	0 – 17 years	Paternal	Maternal	Both	Total		
Kapwayambale	8,677	568	143	160	871	10	5
Mwambeshi	32,912	2,905	737	944	4,586	14	6.6
Ngwerere	30,302	3,191	811	962	4,962	16	7.5

Source: CSO (2013a): 2010 Census of Population and Housing: Descriptive Tables, Series A, B, C and D, Lusaka Province, Central Statistics Office, Lusaka; and own computation

5.4.3 Indigenous People in the Project Communities

Accepting the fact that Lusaka is a cosmopolitan city with a composition of all 72 Zambian tribes there are no indegenous people in the project communities.

5.4.4 Education Level and Facilities

In any of the project areas, only basic schools exist; two in each location, while secondary and tertiary schools do not exist as indicated in Table 5-14. In Ngwerere Ward (Manchinchi WWTP) and Mwambeshi Ward (Chunga WWTP) one teacher is educating about 45 pupils. In the basic schools in Silvia Masebo Compound 56 teachers are at work, but the number of students was not made available to the consultant.

In Lusaka District 5.3% of the population above the age of 5 never attended school. About 24% attained primary school as highest level of formal education, while 24.65% finalized secondary school and 8.3% obtained a tertiary certificate.

In the neighbouring Chongwe District, to which Silvia Masebo Compound belongs to, 18% of the respective population group never attended school. Primary level as highest education level is achieved by 49.65%, while 22.73% attained secondary school level, and 5.5% even achieved tertiary school level. The following Table 5-15 gives a district-wise overview on school attendance per age group.

Table 5-14: Level of education attained in Chongwe and Lusaka districts

Age Group	Chongwe District			Lusaka District		
	Never Attended	Ever Attended		Never Attended	Ever Attended	
		Currently Attending	Not Currently Attending		Currently Attending	Not Currently Attending
5-9	11,956	13,994	749	60,006	145,032	8,647
10-14	1,691	22,285	1,287	7,561	189,556	12,491
15-19	1,063	14,351	5,634	4,953	135,61	55,862
20-24	1,473	2,66	11,348	6,884	35,709	143,697
25-29	1,653	666	11,467	7,499	12,445	160,559
30-34	1,487	401	9,651	6,161	7,087	133,716
35-39	1,217	267	7,86	5,054	4,873	103,014
40-44	909	156	5,5	3,422	2,523	62,458
45-49	814	109	4,167	2,909	1,415	42,709
50-54	834	67	3,211	2,712	810	28,981
Above 55	3,97	197	6,713	11,862	1,288	48,348
Total	**27,067**	**55,153**	**67,587**	**119,023**	**1,336,830**	**800,482**

Source: CSO (2013a): 2010 Census of Population and Housing: Descriptive Tables, Series A, B, C and D, Lusaka Province, Central Statistics Office, Lusaka

Table 5-15: Availability of basic and secondary schools in the project areas

Education infrastructure	Ngwerere Ward (incl. Chilulu, Garden and Luangwa compounds)	Mwambeshi Ward	Silvia Masebo Compound
Basic schools; students	2; Ngwerere Basic School and Simon Mwansa Kapwepwe Basic School	2	2; number of permanent students unknown
No. of teachers	pupil to teacher ratio is approx. 45	pupil to teacher ratio is approx. 45	56
Secondary schools; students	None	None	Non; next is in a distance of about 35 km

Sources: CES community meetings, September 10-12, 2015
Questionnaires and interviews with ward councillors, October 06-07, 2015

5.4.5 Economic Activities and Livelihoods

The City of Lusaka is the major centre of economic activities in Zambia and accounted already in November 2007 for about 50% of any business establishments according to the CSO database (JICA 2009). Lusaka accounts also for almost 50% of the total number of employees in the national manufacturing industry (LCC and ECZ 2008). Nonetheless, despite the concentration of economic activities or (value-added) wealth in the City, urban economic structure is still dominated by the informal sector (JICA 2009).

In terms of household income, CSO (2011) recorded the second highest average monthly income for households in Lusaka Province (ZMW 1,779)[3]. Table 5-16 gives the average monthly income distribution for Lusaka Province.

Table 5-16: Average monthly income of households in Lusaka Province: % of households, and their distribution across urban population strata

Province/ Residential areas	Average monthly income (ZMW)									Average income (ZMW)
	Less than 50	50-150	151-300	301-450	451-600	601-800	801-1000	1001-1200	Above 1200	
Lusaka	2.4	3.3	7.2	10.8	9.7	11.4	8.4	6.2	40.6	1,779
Low cost	1.4	3.3	9.8	12.2	11.4	12.5	9.3	6.7	33.2	1,403
Medium cost	1.3	1.6	2.3	5.2	3.8	5.6	5.9	4.8	69.4	2,852
High cost	1.9	0.5	3.0	5.6	3.7	5.3	5.9	2.9	61.3	4,308

Source: CSO (2011): Living Condition Monitoring Survey Report 2006 and 2010, Central Statistical Office

CSO (2011) grouped the population in two categories: labour force and inactive population[4]. The labour force for Lusaka Province comprised about 60%, out of which 40.6% were in paid employment; 2.5% being unpaid family workers and 16.8% being unemployed (CSO 2011). Unemployment rates for Lusaka Province were calculated as 28%, with females having higher unemployment rates (34.9%) than the males (22.3%), (CSO 2011).

The private sector is the next largest employer, employing 15% of men but only 5% of women, while the public sector accounts for 6.7% of employees with most of these working for the Central Government.

CSO (2013b) established that among the population of Lusaka District about 40% are economically active. The employment status of economically active population ranged from employers and employees to self-employed and unpaid family workers. There were a total of 1.9% employers and 60.9% employees, 35.3% were self-employed and unpaid family workers made up 1.9%. Table 5-17 gives the distribution of employed persons in urban areas.

Table 5-17: Distribution by employment category in Lusaka Province (%)

Employment status	Male	Female	Both sexes
Self employed	35.8	50.4	41.6
Central government employee	11.9	12.5	12.1
Local government/ council employee	1.4	0.7	1.1
Parastatal/ Quasi-govt Employee	3.1	1.3	2.4

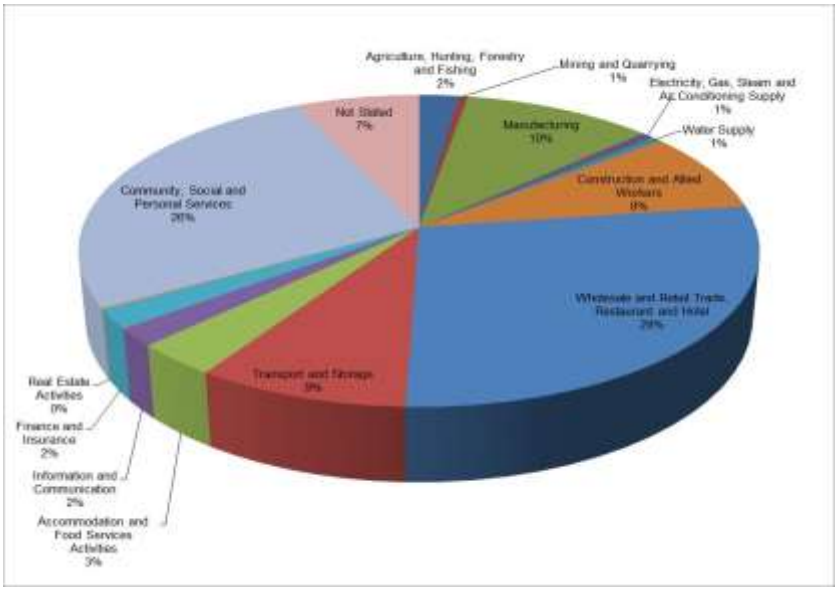
[3] The monthly highest average household income is registered in the Copperbelt Province: ZMW 1,903

[4] Paid workers, unpaid workers and the unemployed (as long as they are looking or available for the labour market) are all classified as economically active and are therefore part of the labour force. While others are termed economically inactive -- they are neither working nor looking for work, and comprise students, retired people, homemakers, or are too ill or disabled to work (CSO 2011).

Private Sector employee	35.7	17.2	28.3
NGO Employee	1.1	1.5	1.3
International Organisation/Embassy Employee	0.2	0.2	0.2
Employer/ partner	0.6	0.3	0.5
Household Employee	2.5	5.8	3.8
Unpaid Family worker	1.9	6.2	3.6
Piece Worker	4.0	1.4	3.0
Other	0.4	0.2	0.3
No information	1.4	2.2	1.7

Source: CSO (2011): Living Condition Monitoring Survey Report 2006 and 2010, Central Statistical Office

Industrial sectors in Lusaka District are presented as Figure 5-6: most of the labour force is hired in the wholesale and trade sector (28%) followed by community, social and personnel services (26%).



Source: CSO (2013b): 2010 Census of Population and Housing: Descriptive Tables, Series E – Economic Tables, Lusaka Province, Central Statistics Office, Lusaka

Figure 5-6: Distribution of working population by sectors in Lusaka District

Economic Activities and Livelihood Sources in the Project Area

Unemployment ratio in the project area was stated to be significant above the general ratio for Lusaka District. In the Silvia Masebo Compound the overall unemployment ratio was estimated to be around 75%, while in the neighbourhoods of Manchinchi and Chunga WWTP the unemployment ratio are estimated to be above 95%. However these figures refer to formal employment. Respectively, the number of self-employed people in these two wards is ranging between 80-90% as shown in Table 5-18. This includes the sale of own products (vegetables, flowers) or second-hand items, charcoal etc.

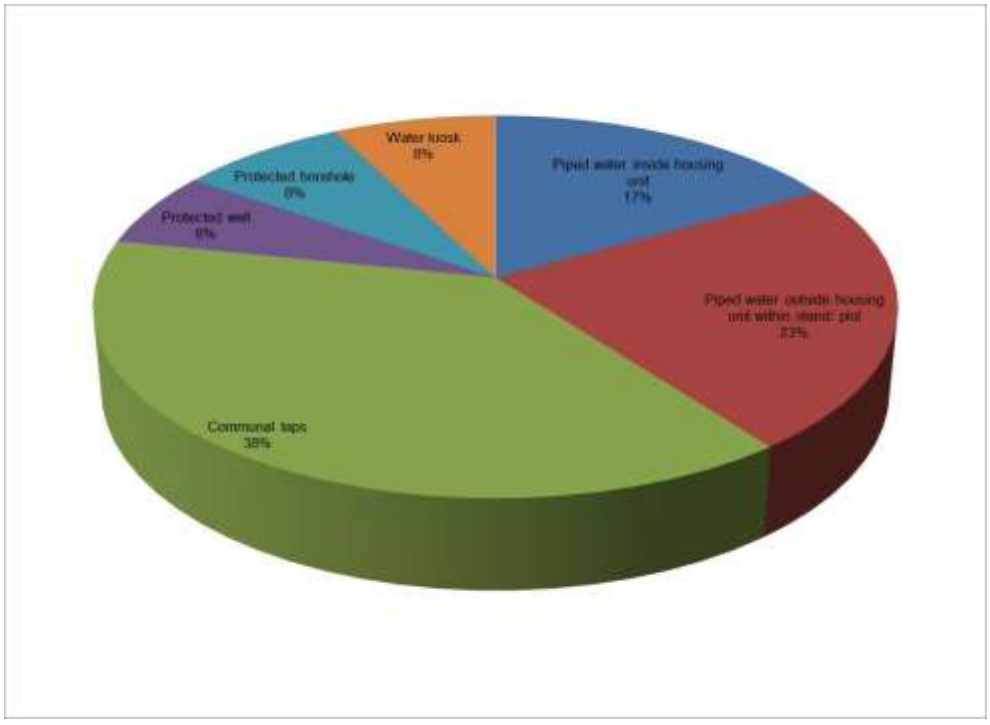
Table 5-18: Employment conditions in the project areas

Economic parameter	Ngwerere Ward (incl. Chilulu, Garden and Luangwa compounds)	Mwambeshi Ward	Silvia Masebo Compound
Unemployment %	~ 98%: only about 2% of the residents are in formal employment	95% acc. to ward councilor's estimation	at least 75%
Main income sources	Self-employment: ~ 80%	Self-employment: ~ 90%	No data accessible

Sources: CES community meetings, September 10-12, 2015
Questionnaires and interviews with ward councillors, October 06-07, 2015

5.4.6 Water Supply Service

Lusaka District has a total of 358,871 households and a population of 1,747,152 (CSO 2013c). At least 85% of the district population has access to safe water supply. Sources of safe water supply include individual household connections, protected boreholes, protected wells, communal pipes, water kiosks and piped water outside housing units but within stand/ plot as shown in Figure 5-7.



Source: CSO (2013c): Census of Population and Housing: Descriptive Tables, Series F, G, H and I, Lusaka Province, Central Statistics Office, Lusaka

Figure 5-7: Population with safe water supply in Lusaka District

Water Supply Service in the Project Areas

In Ngwerere Ward and Mwambeshi Ward neighbouring Manchinchi and Chunga WWTP, respectively, the majority of the population has quantitative access to drinking water; in the Mwambeshi Ward around 65% of the population counts with in-house connections. However, this figure does not provide information neither on the water quality nor on the reliability of water supply. In the Silvia Masebo Compound drinking water sources are only 3 shallow wells which are reported to be contaminated by anthropogenic impacts.

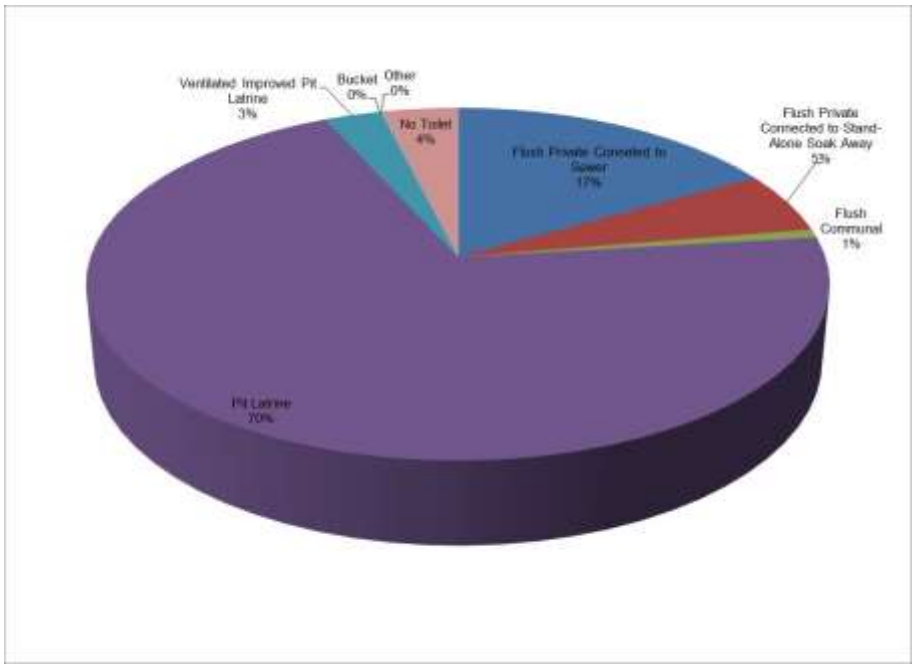
Table 5-19: Water supply service in the project area

Water supply infrastructure	Ngwerere Ward (incl. Chilulu, Garden and Luangwa compounds)	Mwambeshi Ward	Silvia Masebo Compound
In-house connections	~ 25%	~ 65%	0%
Tap in yards	~ 65%	~ 20%	0%
Public standpipes	~ 10% (mainly communal taps)	~ 15%	0%
LWSC water tanks		1 (leaking)	0%
Shallow wells		several individual wells / boreholes – no exact data available	3 (about 6 m deep)
Boreholes			0%

Sources: CES community meetings, September 10-12, 2015
Questionnaires and interviews with ward councillors, October 06-07, 2015

5.4.7 Sanitation Services

70.1% of the households in Lusaka District use pit latrines as sanitation system. Only 23.1% households use flush toilet, out of which only 16.8% are connected to the sewage network system while 5.6% depend on septic tanks and soak-away systems (CSO 2013c). Figure 5-8 displays further data.



Source: CSO (2013c): Census of Population and Housing: Descriptive Tables, Series F, G, H and I, Lusaka Province, Central Statistics Office, Lusaka

Figure 5-8: Distribution of wastewater treatment systems in Lusaka District

Sanitation Services in the Project Areas

Most of the households neighbouring the current WWTPs are using pit latrines. Only in the wards of Ngwerere and Mwambeshi 16.8% are connected to the sewer. In Silvia Masebo Compound the entire population is using pit latrines.

Table 5-20: Sanitation services in the project areas

Sanitation infrastructure	Ngwerere Ward (incl. Chilulu, Garden and Luangwa compounds)	Mwambeshi Ward	Silvia Masebo Compound
Sewer connection	~ 30% - available in Garden Site 3 and 4 and part of Luangwa compound	~ 65%	0%
Pit latrines	~ 85%	~ 90% - almost all the households have pit latrines as alternative toilet facilities	~ 100% - all as temporary constructions
Septic tanks	~ 10%	~ 20%	0%

Sources: CES community meetings, September 10-12, 2015
Questionnaires and interviews with ward councillors, October 06-07, 2015

5.4.8 Human Health

There are generally more cases of malaria in PUAs compared to other urban areas of Lusaka. This is mainly due to poor sanitary and environmental conditions. Limited access to health services contrib-

utes to severity of any disease as in-time treatment is often not available. Waterborne diseases such as diarrhoea, cholera and dysentery are quite common in PUAs and the project locations.

HIV/AIDS prevalence is a major problem in Zambia. The overall HIV prevalence among all women and men age 15-49 tested in the 2013-14 ZDHS was 13% (CSO et al. 2015). Latest figures (CSO et al. 2015) reported HIV/AIDS cases in Lusaka Province to be 16.3%, with 19.4% positive women and 13% HIV positive men.

Specific data on water borne diseases occurring in the neighbourhood of the current WWTP systems do not exist. However, residents reported that malaria and diarrhoea are most common in their communities. Some households use water from shallow wells and boreholes for drinking purposes, likely to be contaminated by unsealed excreta pits. In Silvia Masebo Compound neighbouring the Ngwerere ponds residents suspect that the wastewater from ponds is infiltrating into their groundwater.

In general, the incidence of malaria has declined at district level since 2003 due to indoor residual spraying programme and other anti-malarial interventions that have been introduced such as the use of treated mosquito nets.

5.4.9 Land Use and Land Tenure Systems

All land in Zambia vests in the President. Three land tenure types exist in the country, namely: customary tenure, leaseholds of state land, and squatting.

Under customary law, land is held by individuals, families, clans, or communities from generation to generation, without temporal limitation. Customary tenure applies to individual plots, forestland, common land within a village, and communal grazing land, and majority of land in Zambia (estimated at 84% in 2005) is held under customary tenure (USAID, undated).

Most urban areas, mining areas, protected areas, land along rail lines, and land that was free of tsetse fly infestation during colonial times tends to be state land, much of which has been privatized through leaseholds. The state grants four types of leases: (1) a 10-year Land Record Card; (2) a 14-year lease for un-surveyed land; (3) a 25- to 30-year Land Occupancy License for residential settlements; and (4) a 99-year leasehold for surveyed land (USAID, undated). Squatting involves the majority of the population living in informal settlements in urban areas. USAID (undated) observed that in areas where settlements are built on primarily public land and the structures meet building standards, residents could regularize their rights with 30-year renewable Land Occupancy licenses, although in other informal settlements the residents do not have rights to their residential land under formal law.

Majority of the land in communities likely to be affected by the project is used for residential development. Nonetheless, some of the land is also used for agricultural and vegetable production for both consumption and sale. Land use in the City of Lusaka could be summarized as follows:

- Residential and small-holdings: approximately 30% of the total municipal area
- Agricultural cultivation: about 10% of the Lusaka district area
- Majority of the PUAs are located towards the north, north-west and south of the CBD
- Majority of the formal residential development occurs to the east of the CBD

5.4.10 Culture and Heritage

The City of Lusaka is named after a historical site where Chief Lusaka of the Soli people resided. Manda Hill area hosts the traditional graveyard of the first settlers. Other sites of cultural heritage and historical importance include the memorial site in Chilenje, where the first Republican President lived during the struggle for political independence; the presidential burial site at Embassy Park; and Football Heroes Burial Site.

Nonetheless, there are no known sites of cultural, archaeological and historical importance close to the project sites apart from the Ngwerere graveyard which borders the Chunga WWTP site.

5.4.11 Transport and Site Accessibility

The City of Lusaka has a well-developed road network system linking the CBD to various parts of the City as well as to various towns and cities in the country. The main road network in Lusaka forms an urban area pattern along the Great North Road (GNR), Great East Road (GER), Kafue Road (T2), Mumba Road (M9) and Cairo Road. The T2 connects Zambia to countries in southern and eastern parts of Africa, and particularly ports of Beira in Mozambique, Durban in South Africa, Dar-es-Salaam in Tanzania and Mombasa in Kenya.

The national North-South railway line divides the urban area into western side and eastern side. The two airports in Lusaka, the City Airport and the Kenneth Kaunda International Airports (KKIA), are in operation although the City Airport is mainly used by the Zambia Air Force (ZAF). There are five bus stations located in the city centre; four of which are for local commuters (Soweto/ City Centre, Kulima Tower, Lumumba and Millennium bus stops), and one bus stop (Inter City Bust Terminus) being for inter-town and international travel. In addition, there is a railway station located in the CBD area for both passengers and goods.

Considering the project areas a brief description of the accessibility of the sites is provided hereafter.

Manchinchi WWTP is accessed through the Great North Road (GNR), the T2, as well as through the Great East Road (GER), the T4. Access to Manchinchi WWTP from T2 is through the Makishi Road. From the Church Road, the Makishi Road runs northwards through Rhodes Park crossing the T4

Road into Northmead and then curves westwards between Northmead and Chilulu, crosses the rail line into Emmasdales before joining the GNR at Emmasdale Police Station.

The Manchinchi Road links into T4 at Manda Hill cross junction. The Manchinchi WWTP is located off the Manchinchi Road, at the corner of Garden and Manchinchi roads.

Manchinchi WWTP is also be accessed through the Katima Mulilo Road which also connects between the T4 and T2 roads.

Chunga WWTP: The main access to Chunga WWTP is through the Lumumba Road as well as the T2. The Commonwealth Road which joins the Lumumba Road at Matero Police Station in Matero Township is the primary access to the Chunga WWTP. This runs roads westwards from the Lumumba Road through Matero, George and Lilanda townships before joining the Barlaston Park Road and eventually the Chingwere Road. The Chingwere Road leads to the Chunga WWTP.

Alternatively, the Chunga WWTP is accessed using the Chitanda Road. The Chitanda Road joins the Commonwealth Road at in Matero Township and runs north through Matero and Chunga townships before joining the Chingwere Road. The final section accessing the WWTP is a small road in poor condition.

Ngwerere ponds: The Ngwerere ponds are accessed through the Ngwerere Road off the GNR (T2). The Ngwerere Road joins into the GNR from the eastern direction approximately 12 km north of the Cairo Road/ Church Road junction.

The final section accessing to the ponds is a small, unpaved road in poor condition with a total length of about 500 meters. This road is also the access road to the Silvia Masebo Compound and is running along residential areas as shown in the next Figure 5-9.

Source: CES, June 2015

Figure 5-9: Access road to Ngwerere ponds

6 IMPACT IDENTIFICATION AND ANALYSIS INCLUDING CUMULATIVE IMPACTS

In this chapter of the ESIA Report possible environmental and socio-economic impacts are assessed. Hereby the **preferred Option 5 is considered exclusively**; for Options 1-4C reference is made to the Draft ESIA Report submitted in November 2015.

On one hand, these impacts will result from activities to be carried out during the construction and/or operation phases of the respective treatment option.

On the other hand, given by the complex scope of the ESIA study there are selected environmental topics which have an overwhelming importance for the identification of the most adequate treatment option. This includes:

- WWTP land requirements including impacts related to the potential wastewater transfer
- Impacts on water resources (reduction of pollution loads)
- Sludge-to-energy options (biogas generation and recovery potential)
- Impacts on climate, atmosphere and proposed project structures (Climate Check)
- Future sewage sludge generation and disposal/reuse options.

Respectively, these topics are investigated and presented in thematic order, here impacts on the physical and biological environment, followed by the potential environmental and socio-economic impacts during the WWTP construction and operation phases.

6.1 Physical Environment

6.1.1 WWTP Land Requirements

Facing the growing level of urbanisation in Lusaka City, land requirements for the WWTP extension or construction is representing an essential factor. The next Table 6-1 is providing an overview on the land requirement of Option 5.

Today Manchinchi and Chunga WWTPs are covering areas of 28 ha and 14 ha which cannot be extended as both sites are fully surrounded by settlements. Here, the existing areas and its boundaries are the available resource in the ownership of LWSC. Ngwerere pond system is covering an area of 24 ha that is also in the ownership of LWSC.

Table 6-1: Option 5 - WWTP land requirements in hectares in the reference years 2025 and 2040

Options	Reference year			Additional land requirement?
	2015 (existing)	2025	2040	
Manchinchi WWTP	28	area to be sold		- WWTP abandoned*
New Chunga WWTP	14	14	14	- No, only existing area
New Ngwerere WWTP	24	24	~34	- Yes, additional land requirement - existing pond system to be replaced

* - 2.3 ha remaining for faecal sludge acceptance and transfer station

Source: COWI (2016) - Feasibility Study - Final (Appendix H - Option 5 Analysis)

Option 5 suggests that Ngwerere pond system will be replaced by conventional treatment system. Until the year 2025 the existing site of 24 ha is sufficient, while under the requirements of the year 2040 additionally ~10 ha of land are needed, then totalizing to ~34 ha. The new Chunga WWTP will be re-constructed by replacing the existing trickling filter system and connected structures. The existing site of 14 ha is sufficient; no additional land in the year 2040 is required. The Manchinchi WWTP will be abandoned; however a small plot of 2.3 hectares will serve as faecal acceptance and transfer station.

The Garden ponds will be decommissioned and the area is proposed to be sold. Eventually, due to the long term operation of the site a decontamination might be needed. .

6.1.2 Option 5 - Impacts Associated with Wastewater Transfer

6.1.2.1 Technological Concept

Wastewater generated at Manchinchi WWTP is proposed to be conveyed to the new Ngwerere WWTP for treatment. The flow will be by gravity all the way up to the new Ngwerere WWTP mainly along the existing CSU-07 pipeline route. The proposed material for the gravitational pipeline is concrete.

The existing sewer line from Manchinchi to Ngwerere (CSU-7) runs approximately 10,400m northeastern direction. The line has around 140 manholes spaced at an average distance of 75m. A condition and manhole survey was conducted by the EIB FS Consultant in March establish the status of the sewer line including the manholes, to investigate the alignment and identify potential bottlenecks. The findings are summarised in the following

Table 6-2.

Table 6-2: Findings of the wastewater transfer pipeline survey

Section	Compound	Dimension	Bottlenecks identified by COWI
Manchinchi WWTP			
M 140 - M 132	Garden	DN 900	
M 132	Garden	DN 900 > CSU 7	Overflowing, structures build on top of the pipe; **in the section M 132- M 105 several M below ground level**
M 132 - M 118	Garden	DN 300	Overflowing, structures build on top of the pipe
M 118 - M 98		DN 900	Structures built on top of the pipe
M 98 - M 94	Mazyopa	DN 600	Structures built on top of the pipe > re-routing proposed
M 93 - M 1		DN 900	
Ngwerere ponds			

Source: COWI (2016): FS Final - Appendix H - Option 5 Analysis

With reference to the identified bottlenecks it is evident that these findings have impacts on the environmental and socio-economic conditions. Allowing for an initial assessment anadditional site survey focusing on these potential impacts was executed.

6.1.2.2 Initial Impact Analysis

Following the identification of potential bottlenecks along the wastewater transfer pipeline causing impacts during the replacement process of the existing pipeline, the subsequent investigation executed by the ESIA Consultant was serving two objectives:

- the initial identification of environmental and social relevant issues potentially requiring the application of safeguard measures, and
- the assessment of the requirement to prepare a Resettlement Action Plan.

For this purpose a two-step based investigation program was designed and executed. Initially, aerial photographs indicating the existing and planned pipeline course have been evaluated in order to identify critical hotspots such as local markets, economic activities, churches and other socially relevant entities. These outcomes thereafter have been verified by respective site visits along the pipeline course. All findings have been detailed by concerned sections are summarised in Table 6-3.

The findings revealed that the starting section of the pipeline course from Manchinchi WWTP to the CSU-7 crossing (section M 140 – M 132) and the end section from Mazyopa Compound to Ngwerere ponds (section M 74 – M 1) are considered as unproblematic.

In contrast, the pipeline section crossing Mazyopa Compound (section M 98 – M 75) is considered as highly problematic due to multiple reasons.

Table 6-3: Environmental and social relevant findings along the wastewater transfer pipeline course

Section	Compound / occupation	Dimension	Observations made by ESIA Consultant	RAP required?
Manchinchi WWTP				
M 140 - M 132	Garden	DN 900	No observations made.	No
M 132 - M 126	Garden	DN 900 > CSU 7 > DN 300	In general, houses built too close to the sewage mains. Pipeline route section completely encroanched. In majority, wall fences have been built across the pipeline course. Negotiations with land owners for space to be freed up the pipeline course to be instituted.	No
M 125 - M 120	Garden	DN 300	Pipeline course passes through the church ground just before crossing under the Katima Mulilo Road. There is adequate land to re-route with minimum disturbance.	No
M 119 - M 104	Garden	DN 300 (to M 118) > DN 900	Pipeline course passes through a block of shops ('shopping centre'). The 'shoppinng centre is opoosite the church on the northern side of Katima Mulilo Road. Some wall fences have been built across the pipeline course. Negotiations with land owners for space to be freed up the pipeline course to be instituted.	No
M 103 - M 101	Garden	DN 900	Pipeline course flows along the road. No observations made. Kasangula Road forms a boundary between Garden Compound and Roma Township. The road borders Garden Compound along the northwestern and northeastern side.	No
M 100 - M 99	Roma	DN 900	Pipeline course flows along the road. No observations made. Nevertheless, pipeline course crosses Kasangula Road and the Nanzila Road before traversing through Mazyopa Compound.	No
M 98 - M 75	Mazyopa	DN 900	In general, this section of Mazyopa Compound does not have a logical planning for the houses and other structures. Encroachment of built up structures in this section appears to be rampant. Some structures as well as houses are built across the pipeline course. **In case of crossing the compound some families would have to be moved. Re-routing of the pipeline is possible and proposed.**	No, in case the pipeline will be re-routed.

Section	Compound / occupation	Dimension	Observations made by ESIA Consultant	RAP required?
M 74 - M 27	Zambia Railways Reserve Land	DN 900	The pipe flows along the Zambia Railways. Little encroachment along this section, but no settlers have been observed.	No
M 26 - M 1	Small holders	DN 900	The pipeline diverts from the Zambia Railways Reserve Land and flows through the area predominantly occupied by small holding land owners.	No
Ngwerere pond				

Source: CES – Site monitoring along the pipeline course; Date: August 24, 2016

Summary of findings

- RAP: The investigation of all sections has revealed that there is no requirement for resettlement, except the section crossing Mazyopa Compound (section M 98 – M 75). However, as proposed by the EIB FS Consultant crossing this section can be avoided by re-routing this pipeline section. Respectively, applying this measure will avoid the necessity of a Resettlement Action Plan.
- Right of way: All findings presented have been prepared without an in-depth investigation of the rigth of way. Given by the key objectives of this ESIA study and the corresponding resourses, this task is recommended as part of the ESIA studies following the Zambian ESIA study. In this context reference is made to Chapter 9 'Further Proceedings'.

6.1.3 Impact on Receiving Waters

6.1.3.1 Current Impact on Receiving Waters

Nowadays, Manchinchi WWTP including the Garden Ponds, but especially Chunga WWTP are main polluters of the receiving waters. The following Table 6-4 shows the organic load, here expressed as BOD and COD that is discharged into the Garden River, respectively the Chunga River as result of the poor treatment efficiency. Interpreting the table correctly requires the following background information:

- The calculation shown hereafter is representing dry weather conditions, means the period with highest specific concentration of the organic load.
- Chunga WWTP: The COD load of 3,200 mg/l is untypical for domestic wastewater and is underlining the industrial character of the wastewater. This has been confirmed by the EIB FS Consultant who found the industrial load being double as high as the domestic load.
- This calculation is only representing the organic load of the wastewater pollution. Further pollutions would be associated with heavy metal and microbiological discharges, however no data exist hereto.
- Unfortunately, no flow measurement was undertaken at Ngwerere ponds.

Manchinchi WWTP including Garden Ponds: The full BOD treatment efficiency can be attributed to the Garden ponds. Here, depite a massive sludge settlements in the ponds the decomposition of organic load is (still) working.

Chunga WWTP: The results clearly indicated the complete malfunctioning of the WWTP associated with massive pollution of the Chunga River.

Ngwerere ponds: the pond system reliably reduces the inflowing BOD load, however, COD is significantly contributing to the pollution of the Ngwerere River tributary.

Orange marked cells indicate a poor treatment efficiency resulting in effluent values exceeding the imposed standard.

Table 6-4: Organic load discharged into receiving waters by WWTPs

Parameter	Load effluent*	Treatment target**	Treatment efficiency	Flow (dry weather)***	Load discharge
	mg/l		%	m³/d	kg/d
Manchinchi WWTP / Garden ponds					
BOD	34	50	100	32900	1118,6
COD	147	90	61,2		4836,3
Chunga WWTP					
BOD	120	50	41,7	10700	1284,0
COD	(3200)****	90	2,8		34240,0
Ngwerere ponds					
BOD	40	50	100	no flow measurement	
COD	358	90	25,1		

* - COWI Limited (2015a): Flow Measurement and Sampling Report

** - Treatment limits as per SI No. 112 of 2013, Env. Management (Licensing) Regulations, 2013

*** - Dry weather flow based on COWI Limited (2015a): Flow Measurement and Sampling Report

**** - 3200 mg/l COD represents loads from industrial wastewater

6.1.3.2 Future Perspectives

At this point the estimated WWTP treatment efficiency for the reference year 2025 is exemplary introduced. Hereto, reference is made to effluent quality and corresponding reduction rates of the most relevant WWTP design criteria, BOD and COD as shown in the Table 6-5.

Note: The figures provided hereafter do not necessarily correspond with treatment requirements as indicated in the Zambian standard and/or provisions made by ZEMA. In this context reference is made to Chapter 9 'Further Proceedings'.

A full estimation figure including all treatment options and WWTP design parameters (average flows, BOD, COD, TSS, Total Nitrogen, Ammoniacal N, Total Phosphorous, PO4-P and Faecal coli) for the reference years 2025 and 2040 is presented as **Annex 6.**

As resulting from the estimations the BOD load of the inflowing wastewater at the new Ngwerere WWTP will be reduced by ~96,5%, while the estimated reduction rate at the new Chunga WWTP is ~ 95,5%. The corresponding COD load reduction rates are estimated to be ~ 92,6% and ~90,3%.

Comparing these rates with today's treatment efficiencies indicates that in general the organic pollution of all receiving waters will be significantly reduced and the dilution capacity increased. But, with specific view to the COD load, Chunga River and the Ngwerere River would have the highest benefits.

For completion it should be mentioned that under all options faecal coliforms are expected to be eliminated by almost 100%. While, for the parameter Ammoniacal Nitrogen significant differences in the treatment efficiency exist.

Table 6-5: Option5 - Estimated future effluent quality and reduction rates of the organic load

Design parameters	Unit	Influent	Treatment target*	Effluent**	Reduction rate (%)
New Ngwerere WWTP					
Av. dry weather flow	m^3 /d	69967	n.a	69967	n.a.
BOD_5	kg/d	29330	50 mg/l	1015	96,5%
COD	kg/d	61593	90 mg/l	4568	92,6%
New Chunga WWTP					
Av. dry weather flow	m^3 /d	25662	n.a	25662	n.a.
BOD_5	kg/d	11348	50 mg/l	513	95,5%
COD	kg/d	23831	90 mg/l	2310	90,3%

* - Effluent criteria 6 month average

** - 6 month average in cold season

Source: COWI / CES (2015/2016): project calculations

6.1.4 Impact on Groundwater

It is anticipated that the implementation of the wastewater treatment option will have a positive impact on the (sub-surface) groundwater quality. Currently, at Manchinchi and Chunga WWTPs significant concentrations of Ammonia (NH_4-N) as product of the poor wastewater treatment are generated and partly infiltrated into the sub-surface groundwater aquifers. In contrast, at Ngwerere ponds all nitrogen components are within the imposed standards. This situation implies that quality effects on the groundwater quality are site specific, both in terms of their local occurrence and the potential transfer path into the aquifer as indicated in the next Table 6-6.

As no quantitative data from boreholes around the sites are available, potential groundwater quality effects are described hereafter in qualitative terms.

Manchinchi WWTP including Garden Ponds: Both sites, due to the long term operation of the WWTP and/or ponds are assumed to substantially contribute to the sub-surface groundwater pollution. This refers to pin point sources such as the sludge lagoons, sludge drying beds and the faecal acceptance station. Moreover, diffuse groundwater pollution from seepage is also evident.

As Manchinchi WWTP and the Garden ponds are proposed to be decommissioned positive effects on the groundwater quality are expected.

Chunga WWTP: In general, the potential transfer paths as described for Manchinchi WWTP are also relevant for Chunga WWTP. However, due to the industrial character of the wastewater apart from the nutrients, micro-biological parameters may here also contribute to the groundwater pollution.

Considering these facts, a significant improvement of the groundwater quality around the Chunga WWTP is anticipated.

Ngwerere ponds: The effects on the groundwater quality are expected to be low. As mentioned before nitrogen components have been recorded within imposed limits. In contrast, other factors as identified during the community meetings indicate a substantial pollution potential from the settlement itself due to poor sanitation infrastructure.

Table 6-6: Expected impacts of the wastewater treatment options on the groundwater quality

Options	Significance		Remarks
	WWTP site	Receiving water	
Manchinchi WWTP including Garden ponds	high	high	- sites to be abondonned*
Chunga WWTP	high	high	- mainly industrial wastewater
Ngwerere ponds	low	low	- groundwater pollution from ponds (seepage) low - more significant: pit latrines / unprotected wells - application of mineral fertiliser for agricultural production

* - 2.3 ha remaining for faecal sludge acceptance and transfer station

6.1.5 Water Transfer among Catchment Areas and Associated Water Rigths

Under Option 5 significant wastewater volumes are proposed to be transferred from the Manchinchi catchment to the Ngwerere catchment for treatment. This means that the Garden River currently

receiving effluents from Manchinchi catchment will be affected by a significant water loss, whereas Ngwerere catchment would receive significant water transfers as effluent to be discharged into the Ngwerere River. At the same time, effluent discharges (treated wastewater collected in the Chunga catchment) into the Chunga River will significantly increase due to the foreseen extension of the sewer system within the Chunga catchment area. .

Therefore customary water rights downstream of the receiving waters are likely to be affected.

Table 6-7 is providing a first rough estimation of potential future water tansfers. **However, this figure is not representative as it is based on dry wheather flow measurements, only.**

Table 6-7: Estimated water transfers amongst catchments

Catchment / WWTP	Receiving water		Dry weather upstream flow 2015*	Calculated flow from WWTP 2025**	Dry weather downstream flow	Percentage of effluent
	current	future	m³/d			%
Chunga	Chunga River		5,593	25,606	31,199	82.1
Manchinchi	Garden River	Ngwerere River	12,179	57,519	12,179***	0
Ngwerere	Ngwerere River		0	12,448	69,967****	100

Sources:
COWI (2015): Flow Measurements and Sampling Report
* - Sampling date: June 16, 2015 (dry season)
COWI (2016): FS Final - Appendix H - Option 5 Analysis
** - Chapter 2.3, Table 2.2
*** - only flow of Garden River > wastewater flow transferred to Ngwerere catchment/WWTP
**** - combined flow of calculated wastewater flow plus wastewater transfer from Manchinchi catchment/WWTP

Nonetheless, the figure is allowing the following suggestions:

- Chunga catchment: The calculated effluent flow from Chunga WWTP to Chunga River in the dry season is more than 80%. That means that in the future the dry weather flow downstream of the discharge point of the WWTP will be six times of the current flows. Under consideration of the yet unknown flows during the raining season there is a risk of flooding in case the current capacity of the Chunga River is unsufficient to deal with these increased amounts.
- Manchinchi catchment: Following the 2025 estimations, around 57,500 m³ of wastewater per day will be transferred to Ngwerere catchment. After decommissioning of Manchinchi WWTP and the connected Garden ponds, all effluent flows into the Garden River are stopped. All activities currently relying on poorly treated wastewater (nearby small-scale irrigation, production of pottery goods) will be affected.
- Ngwerere catchment: In the year 2025 around 57,500 m³ per day will be transferred to Ngwerere. Together with the flows of the Ngwerere WWTP at total effluent flow of almost 70,000 m³ per day is generated. However, during the dry season the natural flow in the Ngwerere River was recorded to be zero; thus all water in the river would be effluent. Similarly

as for Chunga River, the capacity of the Ngwerere River might be a limiting factor linked to the risk of flooding.

This situation goes along with the decommissioning and demolishing of the existing poor treatment pond system; today an easy accessible source for irrigation by the neary residents (even as illegal practice).

Due to the missing hydrological data characterising the concerned catchment areas during the rain season does not allow the in-depth identification and investigation of customary water rights. It is recommended to perform these investigations as part of the ESIA in accordance with the Zambian ESIA standard. Reference is made to Chapter 9.1 'Requirement for Additional Studies' where additional studies to be subject under the Zambian ESIA standard are assembled and the respective content briefly summarised.

6.1.6 Sludge Disposal and Reuse

6.1.6.1 Current Sludge Disposal Practice

In general, the sludge management practice as recorded at Manchinchi WWTP is also applicable for Chunga WWTP. The co-settled sludge is marginally thickened and dried on the drying beds, during the rainy season it is stored in a sludge lagoon. Parts of the drying beds are completely overgrown with weed and shrubs. The lagoon most likely does not have a protective basis layer.

Semi-dry sludge is sold to local agriculture and horticulture small scale farmers on demand without quality monitoring. Both, for Manchinchi and Chunga WWTPs, it was reported that the 'demand' by farmers is higher than the available supply volumes. Also, farmers are willing to pay for the sludge.

By chance, during the site visit at Chunga WWTP dated June 18, 2015 a local farmer was met collecting sludge from the WWTP lagoon. The interview has revealed interesting insights of the sludge management practice and subsequent agricultural application.

- The farmer stated that he is collecting sludge 2-3 times per year, paying 7.5 Kwacha per ton to the WWTP operator.
- The transport is organised with own small truck; the transport distance is about 5 km (one way).
- Cultivated crops: mostly vegetables, amongst cucumber, tomatoes, green beans.
- Pricing: No, problem. The farmer would even pay more.

Having in mind the partly industrial character of the inflowing wastewater, especially at Chunga WWTP the resulting sludge could be of poor quality, especially with regard to the concentrations of heavy metals. Here the next chapter will provide more details.

6.1.6.2 Current Sludge Quality

In May-June 2015 the EIB FS Consultant has undertaken a qualitative sludge sampling & monitoring programme as part of their scope of work (COWI 2015a). Sludge samples were taken from Manchinchi and Chunga WWTPs; respective sampling points were the primary sedimentation tanks and the sludge lagoons. Findings of the monitoring are presented hereafter and results are summarised in the Table 6-8.

Today, Zambia has not introduced its own sludge quality standards or regulation. Therefore the results of the monitoring are compared with the EU 'Sludge' Directive (86/278 EC)[5] and the South-African sludge disposal standard[6]. Both standards have been introduced in detail in Chapter 2.6 'Discharge /Disposal Consent Standards'.

Manchinchi WWTP: With respect to the EU Directive, treated sludge from Manchinchi plant meets the values for all the analysed heavy metals. Chromium, which is a conspicuous problem with sludge at Chunga WWTP was found in very low concentrations.

While sludge collected from the primary sedimentation tank shows a high concentration of zinc, but still within the limits of the EU sludge standard. While sludge collected from the sludge lagoon was well within the given limits of both standards. Unfortunately, no monitoring of the micro-biological parameters was done at both WWTPs.

Respectively, with reference to the concentration of heavy metals sludge from Manchinchi WWTP would be suitable for reuse in agriculture.

Chunga WWTP: Although Chunga WWTP is predominantly for the treatment of domestic sewage, there are industrial discharges into the system leading to the presence of heavy metals such as lead, cadmium, mercury, nickel and chromium in the wastewater.

Based on the available results, it is evident that with respect to the EU Directive limit values, heavy metal contamination for all metals analysed does not represent a problem to plants and/or human health. Except chromium (not regulated), they all occur in levels much lower than the recommended maximum allowable concentrations (MAC). With respect to the South-African sludge standard, chromium is significantly exceeding the imposed limits.

The exaggerated chromium concentration in the sludge is anticipated due to the presence of tanneries in its catchment. The observed levels are 1.3 to 2 times higher than the stipulated South-African

[5] EU Sludge Directive 86/278 EC – Council Directive on the protection of the environment, and in particular of the soil, when sludge is used in agriculture.

[6] Guidelines for the Utilisation and Disposal of Wastewater Sludge Volume 1 of 5 Selection of Management Options, prepared for the Water Research Commission, Golder Associates Africa, WRC Report No. TT 261/06 March 2006

standard which raises a concern especially that chromium has effects on both plants and human beings. Respecting the current findings sludge of Chunga WWTP is not suitable for agricultural reuse.

Table 6-8: Manchinchi and Chunga WWTPs: Sludge quality monitoring results. Orange marked fields indicate the exceeding of maximum limit values.

Parameter	Unit	Limit values		Chunga WWTP		Manchinchi WWTP	
		EU	RSA	Primary sedimentati-on tank	Sludge lagoon	Primary sedimentati-on tank	Sludge lagoon
pH				7.72	7.44	7.34	7.58
Humidity	%			23.25	3.90	43.24	4.79
Total Solids	mg/kg			72.3	77.6	58.5	74.4
Ammonia Nitrogen				17.6	17.6	18.5	17.6
Nitrate Nitrogen				<0.1			
Total Phosphorus				10.4	2.9	10.7	2.0
Total Phosphate				12.5	3.1	12.1	2.1
Potassium	mg/kg DS			1964	1474	990	1337
Magnesium				4552	3102	13039	8449
Calcium				57125	52733	143326	81551
Manganese				552.6	1098.4	273.8	270.9
Cadmium		20-40	85	<0.06			
Copper		1000-1750	4300	163.2	164.1	187.9	247.5
Chromium			3000	3980.5	5885.9	68.1	46.3
Nickel		300-400		59.3	43.9	147.0	58.9
Lead		750-1200	840	109.0	113.7		101.1
Zinc		2500-4000		1185.7	1097.4	3186.4	1285.6
Mercury		16-25		<0.06			
Faecal coliforms	CFU/g_{dry}		$1x10^6$	not analysed			
Helminth eggs	total viable ova/g_{dry} in 2 of 3 samples		$1X10^7$	not analysed			

Reference: COWI (2015a) - Flow Measurements and Sampling Report

Summary of findings

- From the methodological point of view the current findings are not representative and can only be seen as a ‘snap shop’ of the current situation (dry weather season). However, the results do not allow any conclusions in view of the seasonal variations (dry vs. wet season).
- Under the current sludge monitoring campaign no micro-biological parameters were analysed. Especially with view to the potential sludge reuse in the agriculture and/or horticulture sectors acceptance of highest hygienic standards is essential.

- With reference to the heavy metal concentrations, sludge from Manchinchi WWTP would be suitable for agricultural reuse, while sludge from Chunga WWTP would need to be disposed otherwise.
- Current high concentrations of some heavy metals (chromium, zinc) are the result of industrial activities. Respectively, management of industries is the key factor for future sludge quality. It should be accepted that the chosen future wastewater treatment technology is not likely to remove/reduce heavy metals effectively. Rather high heavy metal concentrations in the WWTP inlet are transferred into the sludge which in return is reducing potential reuse options.
- It is important mentioning that the FS Consultant is not anticipating problems for future sludge-to-energy options (here anaerobic digestion) due to the high concentration of heavy metals, especially chromium, in the sludge of Chunga WWTP.

6.1.6.3 Estimated Future Sludge Generation

The specific sludge quantities result from a) the connected PE, b) the connection rate to the sewer network and the influence of relevant industries and the chosen treatment technology. All these factors were investigated in detail finally resulting in the estimated sludge quantities generated in the reference years 2019, 2025 and 2040 as indicated in Table 6-9.

For the calculation of the total sludge volumes to be disposed and/or reused conservative dry substance content (DS) of 50% as typical for drying beds and/or lagoons under the given climatic regime was assumed. Following these estimations shows that under all options the sludge generation is constantly increasing reaching its peak in the year 2040.

Under Option 5, the sludge generation in the year of the WWTP commissioning is 7,312 tons further increasing to 17,520 tons in the year 2025 and finally 36,048 tons in the year 2040. Considering the pond systems (Options 4/4A) have the lowest sludge generation, while the activated sludge based system proposed under Option 4C is generating much higher sludge volumes.

With view to the future sludge disposal and/or reuse options it has to be stated that all volumes presented hereafter have undergone anaerobic digestion and can be considered as fully stabilised and hygienically safe.

Table 6-9: Option 5 - Estimated future sludge generation

		2019			2025			2040		
	Unit	Manchinchi	Chunga	Ngwerere	Manchinchi	Chunga	Ngwerere	Manchinchi	Chunga	Ngwerere
Sludge generation	t DS/y	-	-	3.656	-	2.444	6.316	-	4.958	13.066
Sludge dewatering (drying beds and/or lagoons)	% DS	-	-	50	-	50	50	-	50	50
Total sludge volume	t/y	**-**	**-**	**7.312**	**-**	**4.888**	**12.632**	**-**	**9.916**	**26.132**

Source: COWI / CES (2015/2016): project calculations

6.1.6.4 Impact of Sludge Quality on Future Disposal/Reuse Options

Accepting the fact that sludge generated at Chunga WWTP contains high concentrations of selected heavy metals this will have consequences on the future disposal and/or reuse options. Under Option 5, by having separated wastewater flows to the New Chunga and New Ngwerere WWTPs contaminated sludge is limited to New Chunga WWTP. Under these conditions sludge quality will be negatively affected and is likely to reduce the reuse alternatives.

6.1.6.5 Future Sludge Disposal and Reuse Options

All potential sludge reuse or disposal options are primarily defined by the respective quality of the sludge. In this context the most likely options, agricultural reuse and sludge disposal at landfills, have been investigated. This also includes 'Sludge-to-energy' option, here anaerobic sludge digestion.

6.1.6.5.1 'Sludge to Energy' Options

First of all it has to be stated that sludge-to-energy options do not represent sludge disposal and/or reuse options as such, rather they contribute to increase the potential suitability for later reuse due to:

- volume reduction;
- sludge sanitation (sludge stabilisation, inactivation of pathogens);
- nutrient concentration; and
- reduction of transport volume.

Anaerobic digestion of the excess sludge converts volatile organic substances into biogas next to the gas production is also obtained a significant reduction of sludge quantities in terms of total solids of around 30%. Along with the inactivation of pathogens, sludge stabilisation forms a prerequisite for later reuse options, especially reuse in the agricultural / horticultural sectors. After anaerobic digestion the sludge needs to be treated further (dewatering, drying) to allow final reuse or disposal.

Due to the importance in terms of the climate change adaptation this issue is elaborated in more detail in Chapter 6.1.9 'Climate Check – Impacts on Climate and Atmosphere'.

In future other technologies such as the co-digestion of sewage sludge with municipal organic waste (and subsequent composting) and/or pyrolysis are among the most promising processes applicable for sewage sludge-to-energy conversion.

6.1.6.5.2 Agricultural Reuse

The fertilisation of the agricultural fields with the sewage sludge from the wastewater treatment process has positive effects on the crops by supplying nutrients like nitrate and phosphorus. It also can contribute to the improvement of the soil fertility due to the high content of organic substance. In contrast, by applying the sludge in agriculture, the hazardous substances included in the sludge can lead to risks for the human health, the soils and the environment in a direct way. Consequently, benefits and risks have to be weighed against each other.

According to the European Sludge Directive (86/278 EEC) up to 5 tons DS per hectare within a 3 years cycle can be applied. That means, after the application of the allowed quantity in the 1st year, a break of 2 years has to be respected. In result, a 3 times higher area demand has to be considered. Alternatively, new areas of arable land could be recruited permanently in order to avoid the overdosing of the areas where sludge had been spread before.

The following Table 6-10 gives a preliminary overview about the area requirement for the reference years 2019, 2025 and 2040. For this estimation the assumption was taken that **all generated sludge** (including sludge from Chunga sewershed) shall be applied in agriculture.

Considering Option 5 an area of 731 ha (respectively 2,193 hectares when applied in a 3 years cycle) is required. This area requirement will increase during the next years in line with the increasing number of population being connected to the respective WWTP finally requiring 3,605 ha in the year 2040.

Table 6-10: Estimated agricultural areas for future sludge application

	Unit	Year 2019	Year 2025	Year 2040
Sludge quantity	t/y (50% DS)	7.312	17.520	36.048
Area requirement	ha/y	731	1.752	3.605
Area requirement within 3-year cycle	ha	2.194	5.256	10.814

Calculation baseline: 5 t DS/ y/ ha within 3 years x 100%/ 50% DS = 10 t/ha

Source: COWI / CES (2015/2016): project calculations

So far the agricultural areas and its crop structure are not investigated in detail. Once having them identified would allow comparing between the sludge generation as introduced before and the potential demand.

6.1.6.5.3 Landfilling

Given the fact that sludge is legally considered as hazardous waste the dumping of sewage sludge is anticipated to be possible. However, from the ecological point of view it would be more environmental-friendly to restore the organic substance and the nutrients contained in the sludge in the natural cycle.

Despite this situation described before, the dumping of sewage sludge could become necessary in case that:

- generated sludge does not meet quality standards that allows an (agricultural) reuse, or
- WWTP sludge storage capacities in order to bridge times where the agricultural reuse is not allowed (rainy season) are depleted.

For this purpose the Lusaka City central landfill located along the Great North Road could offer the potential capacities. The landfill is owned and opereated by the Lusaka City Council. **However, as from initial site visits it has to be stated that the landfill is in very poor condition and completely unorganised. Collected waste is not separated, organic fractions are dumped along with common solid waste types and burning of waste is daily practice.**

Theoretically, here sludge might be finally disposed off or be used as filling material for landfill covering after mixing with mineral soils.

Respecting the fact that sludge dumping should be avoided would necessitate the swift implementation of an effective management system for the industries connected to the public sewer network, especially in the Chunga catchment. Reference is made to Chapter 8.4 ‘Future Management of Industries’ that is directly referring to the industries sector, its discharges and the associated quality of the generated wastewater.

6.1.7 ‘Sludge to Energy’ Options

Anaerobic digestion of sewage sludge forms methane-rich biogas, which can be utilized as fuel to offset heat and electricity consumption of the future WWTPs. Generated biogas contains about 60-70% methane (CH_4) and a typical gas yield is in the interval 5 to 6 Nm^3 CH_4 per PE per year (some 50 kWh per PE per year) depending on the composition of digested sludge, i.e. the greater the proportion of primary sludge the higher gas production. Biological filter sludge is mainly composed of dead microorganisms, which are partially degraded in the biological processes, and therefore less suitable as a source of gas production.

As indicated in the next Figure 6-1 biogas can be converted to energy by means of a gas engine where 85-90% of the consumed energy is converted to heat (approximately 50%) and electricity (35-40%).

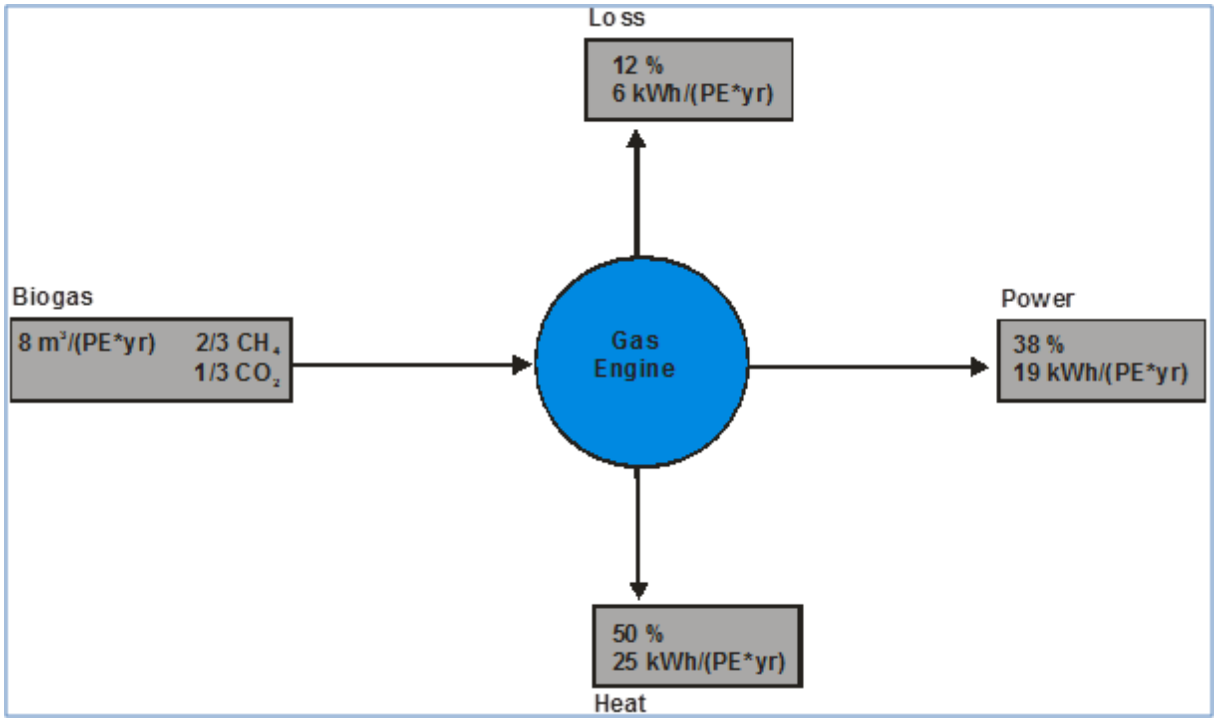


Figure 6-1: Expected energy production from biogas generation process

Concerning the potential for energy generation, the high concentration of organic matter in the raw sludge is indicative of the high methane production potential of the sludge. However, the presence of metals may have some inhibitory effects. Of concern are heavy metals (e.g. chromium, zinc) which may be toxic to the microorganisms responsible for the anaerobic biodegradation process. However, it is expected that these concentrations found in the sludge of Chunga WWTP are not in levels that can severely affect the processes (COWI 2015b).

Recommended Sludge to Energy Strategy

Operation of a combined heat and power system (CHP) requires great efforts and presence of experienced support organization.

Complying with this situation the EIB FS Consultant has recommended applying the sludge to energy principle in stages. A plant for heat production is installed in the first stage. Based on the operational experience and the financial possibilities upgrading to a CHP plant can be decided at a later stage. This will reduce the risk for installation of equipment that cannot be properly maintained due to lack of technical support.

Biogas Generation and Recovery Potential

Table 6-11 indicates the estimated generation of heat and electricity from the anaerobic digestion process in the reference years 2019, 2025 and 2040.

Heat energy: It has to be noted that this figure is indicating the heat generation available for the heating of the digesters (utilised heat volume). Thus, this figure is less than the total heat generation.

Electricity generation: Recovery of electrical energy is expected to be implemented in later project phases (tentatively 2040). Thus, the stated figures only provide the theoretical recovery potential.

Table 6-11: Option 5 - Sludge-to-Energy: Estimated heat and electricity generation in MJ/d

Site	Year 2019*		Year 2025		Year 2040	
	Heat generation	Electricity generation	Heat generation	Electricity generation	Heat generation	Electricity generation
Manchinchi WWTP	-	-	-	-	-	-
New Chunga WWTP	21.508	13.687	40.512	25.781	82.207	52.313
New Ngwerere WWTP	62.575	39.820	104.708	66.633	216.596	137.834

* Figure estimated

Source: COWI / CES (2015/2016): project calculations

Summary of findings

- ,Sludge-to-Energy in form of anaerobic digestion with subsequent heat and/or energy generation and recovery is foreseen in all investigated treatment alternatives, except Options 4/4A due to the low technological biogas generation potential.
- The preferred option 5 will be equipped with anaerobic digestion process from the very beginning and shall be operational in the proposed year of WWTP commissioning, tentatively 2019.
- During the first operation phase of the WWTP, only heat energy will be utilized (heating of the digesters) for cost recovery.
- Potential use of electrical energy is expected for later phases, tentatively 2040.
- Implementing this approach would guarantee full stabilization of all generated raw sludge. Unstabilized sludge needs to be avoided because of its negative carbon footprint (significant emissions of greenhouse gases).
- Moreover, sludge stabilization is the basis for all sludge reuse options, especially reuse in agriculture and/or horticulture sectors.

6.1.8 Landscape and Visual Impacts

Manchinchi WWTP: In case of Option 5 Manchinchi WWTP will be decommissioned, except of 2.3 hectares to be kept operational as faecal sludge acceptance and transfer station. Hereby the

existing structures are proposed to be rehabilitated which means in terms of visual impacts the present situation will remain widely unchanged.

However, the majority of the current area (~ 26 ha) is proposed to be sold. Before, all existing structures will be dismantled what will have a positive effect on the visual impacts. Beyond this, landscape and visual impacts are subject to the future concept.

New Chunga WWTP: Even though being used as WWTP for many decades, still the site has a semi-natural character. Also, as the area is not fenced nearby inhabitants have a free and uncovered view to the site. WWTP re-construction works as outlined under Option 5 necessitate the full coverage of the WWTP area. In fact, even if trickling filter, digesters and sedimentation basins are partly buried, visual impacts are evident, if not mitigated properly.

In this context specific attention has to be paid to the community graveyard stretching along the access road to the Chunga WWTP compound. Today, the graveyard has already extended beyond its original border until the fence of the existing WWTP. Some graves are placed immediately at the roadside. The graveyard is protected by old trees along the access road. A site inspection has shown that potential construction works (broading of the access road, transfer pipelines, WWTP) are not likely affecting the graveyard. Nevertheless, planting of trees at the WWTP site bordering to the graveyard are recommended.

New Ngwerere WWTP: Implementing Option 5 will have significant visual impacts. Currently, the inhabitants of the Silvia Masebo Compound have a free view to the Ngwerere pond system which does not have any physical structure or equipment placed on the site. Under Option 5 this pond system will be demolished and replaced by conventional WWTP infrastructure that includes buildings, basins and other technical equipment. Moreover, due to the dimensioning of the WWTP these structures will directly border to the residential areas. Even if partly buried into the ground effective mitigation measures are required to minimise the expected impacts on landscape.

Table 6-12: Option 5 - Landscape and visual impacts

	Manchinchi	Chunga	Ngwerere
Effect on the preservation of scenic views and valued features	site to be sold*	moderate	significant
Compatibility with surrounding areas		moderate	
Effect on the character of the area		moderate	
Visual impacts (features, removal of vegetation, etc.)		significant	

Effects on natural heritage sites	No natural heritage site identified.

* - 2.3 ha remaining for feacal sludge acceptance and transfer station

6.1.9 Climate Check - Impacts on Climate and Atmosphere

6.1.9.1 Baseline Criteria and Assumptions

Direct greenhouse gases are e.g. CO_2, CH_4 or N_2O, indirect greenhouse gases (GHG) are amongst others SO_2 and NO_x. For wastewater treatment, two major greenhouse gas emissions have to be considered: The energy demand for the different processes and therefore the CO_2 emissions on the one hand and CH_4 emissions resulting from anaerobic digestions on the other. Yet, the emission of N_2O may also play an important role in case of malfunction of the treatment processes. The following assumptions have been made:

- Emissions at different stages for the relevant option, 'trickling filters with nitrification' are considered.
- All relevant facilities where the wastewater and sludge is treated are considered in all options.
- Power is exclusively sourced from the Zambian electricity grid (no off-grid power plants).
- Initially, the recovered energy will be used in the treatment processes, here the heating of the digesters. Recovery, of both electrical and heat energy (implementation of a combined energy & power unit) is planned for later WWTP operation phase, here tentatively considered from the year 2040 onwards.
- The amount of produced methane in the anaerobic digesting process is not relevant, if it will be transformed during 'heated combustion' (heating of digesters) of biogas to CO_2.
- Consideration of Nitrous Oxide (N_2O) is based on the population equivalents (PE) as calculated by the EIB FS Consultant (COWI 2016, Table 2-2):

  Reference year 2025: Chunga and Ngwerere WWTPs: 542,613
  Reference year 2040: Chunga and Ngwerere WWTPs: 1,449,105
- Generated sludge is considered largely inert due to the anaerobic digesting processes.

6.1.9.2 Consideration of Carbon Dioxide

Following the UNFCCC[7] a conservative default value of **1.3 t CO_2/MWh** has been applied for project power consumption sources versus the corresponding CO_2 generation. In this context, Option 5 would have a rather moderate CO_2 generation rate as indicated in

[7] - UNFCCC: Tool to calculate baseline, project and/or leakage emissions from electricity consumption., p.4

Table 6-13.

Table 6-13: Option 5 - Energy consumption and CO_2 generation

	Year 2019	Year 2025	Year 2040
Total energy demand (MWh/year)	10.007	13.407	23.856
Heat energy recovery (MWh/year)	-5.239	-5.733	-11.795
Net energy demand (MWh/year)	4.768	7.674	12.061
CO_2 emission (t/year) for energy consumption	**6.198,4**	**9.976,2**	**15.679,3**

Source: COWI / CES (2015/2016): project calculations

6.1.9.3 Consideration of Methane

Methane has an enormous global warming potential since it is 21 times as effective as CO_2.

The possibility of gas utilization is provided when produced excess sludge is anaerobically digested, resulting in methane production to be processed in the connected heat unit (later combined heat and power unit). This process allows reducing the energy demand in terms of partial self-supply - thus reducing CO_2 emissions as shown in the chapter before.

The digester captures biogas and utilizes the methane as a fuel for the treatment process. The energy can therefore be recovered.

6.1.9.4 Consideration of Nitrous Oxide

N_2O can be an intermediate product during nitrification and denitrification, but is more often associated with denitrification. Approximately **7 grams N_2O** is generated per capita per year if wastewater treatment includes intentional nitrification and denitrification. Under consideration of the Global Warming Potential of N_2O of 296 t CO_2 e/t N_2O[8] the associated generation is shown in the Table 6-14.

With regard to sludge Nitrous oxide emissions are assumed to be negligible for all project options and need not be accounted for assuming that the sludge is:

- dried under controlled and aerobic conditions, and then disposed and/or reused; or,
- treated in a new anaerobic digester and the residues from the anaerobic digester are dehydrated before final disposal and/or reuse.

6.1.9.5 Comparison of GHG Emissions of Options

For comparison of results, the **global warming potential (GWP)** has to be considered. It is a measure of how much a given mass of GHG is estimated to contribute to global warming. Carbon dioxide has a GWP of exactly 1, since it is the baseline unit to which all other greenhouse gases are compared. The

[8] - UNFCCC (2009): Approved baseline and monitoring methodology AM0080 “Mitigation of greenhouse gases emissions with treatment of wastewater in aerobic wastewater treatment plants”; www.cdm.unfccc.int

GWP of methane is 21 and that of Nitrous N_2O oxide even 296. The determined CH_4 has been converted to CO_2 equivalent to allow direct comparison of the values.

In this context Option 5 has a moderate global warming potential generating a total of 9,978 tons CO_2e emission in the reference year 2025.

Table 6-14: Option 5 - Total CO_2 equivalent emissions in t/year

	Year 2019	Year 2025	Year 2040
CO_2 emission for energy demand	13.009	17.429	31.013
CO_2 emission reduction by gas utilisation	-6.811	-7.453	-15.334
CO_2 equivalent for Dinitrous Oxide	2,1	2,1	7,0
TOTAL CO_2e emission (t/year)	**6.200,5**	**9.978,3**	**15.686,3**

Source: COWI / CES (2015/2016): project calculations

Summary of findings

- Nowadays, Zambia is generating considerable 94%[9] of the total energy from renewable sources, primarily hydropower. In so far, the calculations made before are of informal character as all energy required for the WWTP options was almost generated CO_2-neutral.
- Nevertheless, the calculation shows that energy recovery from biogas utilization can save significant energy volumes, which can be used for other purposes.
- Recent experience shows that the Zambian renewable energy sector is associated with high vulnerability to climate change effects, due to the missing diversification. Over the last months significant rainfall deficits have led to shrinking water levels in the dams and lower energy generation rates. Giving priority to the mining industries, today energy shortages to public services (here operation of wastewater treatment facilities) and supply of the public are common.

  Respecting this fact, as soon as Zambia should increase its level of energy generation based on fossil resources – Mambaa coal fired power station constructed in Sinazongwe District, Southern Province is almost operational – would give the calculations made before growing relevance.
- Consequently, Sludge-to-Energy options should be implemented from the very beginning, independently from the fact which Option is finally selected. This statement refers to the potential energy savings, but also to avoid significant methane emissions as the result of not implementing an anaerobic sludge digestion process (generation of un- stabilized sludge). In this context it should be highlighted again that un-stabilized sludge is not suitable for reuse in agriculture.

6.1.10 Climate Check - Impacts on Project Structures

In Chapter 5.2.10 ‘Climate Change Projection the current available scientific basis analysing climate change affects in Zambia are presented. Given the fact that climate change effects show specific local and regional characteristics information about the occurance of flooding events and areas prone to

9 https://www.hydropower.org/country-profiles/zambia

flooding in Lusaka have been collected. These data have been backed-up with information and observations collected during community meetings on flooding events and its specific impacts (Chapter 5.2.7 'Flood Areas'.

Climate change is likely to may affect the sustainability of the planned infrastructure investment. For the project, the main climate induced effects to consider are (1) rising temperatures, (2) heavy rainfall and flooding, and as of secondary importance (3) drought and water scarcity as well as (4) heavy storms.

Rising temperatures and/or heavy rainfall, these more extreme weather events will lead to runoff, more untreated sewer overflows and increased flooding. Associated potential effects have been preliminary analysed and the findings are presented in Table 6-15. Due to missing quantitative data potential impacts and/or effects on the new Chunga and Ngwerere WWTPs and the wastewater transfer pipeline from Manchinchi WWTP are described qualitatively.

The analysis shows that there are many individual factors which in future might negatively affect the WWTPs, its treatment process or the transfer pipeline. On the other hand, increasing average temperatures might lead to positive effects at the WWTPs as the treatment process can run faster corresponding with a decreasing energy demand.

Table 6-15: Option 5 – Potential climate change impacts on project structures

Factor	Impact / effect
Increasing temperature	
New Chunga WWTP New Manchinchi WWTP	General: trickling filter systems less dependent on temperature as other treatment systems
	Higher temperature and drought has long-lasting influence and endangers first of all the environment
	Decreasing dilution capacity of recipients
	In the long term run higher WWTPs treatment and/or effluent requirements (> reuse potential)
	Positive: biological treatment process and sludge dewatering can run faster
	Positive: cost for heating of anaerobic digesting facilities is lower
New Chunga WWTP New Manchinchi WWTP Wastewater transfer pipeline	Higher pollution load of wastewater and effluent
Increasing temperature - periods without or low precipitation	
	Accumulation of solid waste / sediments and incrustation in the pipeline and WWTPs

Factor	Impact / effect
	Clogging of WWTP installations and wastewater transfer pipeline
	Water rotting in the system attended by unpleasant odour
	Growing risk in disease dissemination
Flooding	
New Chunga WWTP* New Ngwerere WWTP	General: Heavy rainfalls have immediate effect endangering primarily people, structures and technologies
	Backflow from receiving rivers during floods
	Release of untreated/polluted wastewater into the river ecosystem
	Rising downstream water levels may make pumping effluent a requirement with increasing energy demand
Wastewater transfer pipeline	Overflowing of wastewater transfer pipeline in sections below ground level (M 132 – M 105)

* - Today, Chunga site is reported not being affected by floodings; reference is made to impacts (Chapter 5.2.7 'Flood Areas').

6.2 Biological Environment

With reference to Chapter 5.3, considering the biological environment the flora / fauna inventories at all potential WWTP sites can be summarised as follows:

- No threatened, rare or endangered species of fauna or flora were registered or known to exist around the WWTP sites.
- No sensitive or fragile habitats were noted in relation to the extent and magnitude of the envisaged works.
- No species of fauna or flora that could be exploited for commercial purposes have noted in proximity to the proposed works.
- The current degree and extent of the proposed works do not interfere with any protected area.

6.3 Impacts during Construction and Operation

In this section of the ESIA Report, possible environmental and social impacts that may result from activities to be carried out during construction and operational phases are investigated.

Cumulative impacts can result from individually minor but collectively potentially significant actions taking place over a period of time. They can be thought of as occurring through two main pathways,

firstly through persistent additions or losses of the same materials or resource and secondly through the compounding effects as a result of the coming together of two or more effects.

6.3.1 Environmental Impacts during Construction Phase

For possible environmental impacts during the WWTP construction phase reference is made to all WWTP sites including the Garden ponds focusing to the following main activities:

- construction of access roads;
- demolishing of existing structures;
- preparatory works at the WWTP site and grading works;
- construction of WWTP structures and pipeline installation (civil works, use of heavy machinery and vehicles);
- construction of sludge and/or wastewater transfer infrastructure (here interconnecting pipe-lines); and
- installation of the equipment.

Impact description: Construction activities usually generate variety of impacts. Site preparation, earthworks, grading, construction of access roads is likely to lead to: (1) emission of dust and other air pollutants, (2) noise and vibration, (3) vegetation removal and degradation, (4) compaction of soil, (5) potential pollution releases to soil, surface water bodies and groundwater.

Earthworks in combination with transport activities are the main source of dust emissions while emission of other air pollutants (SO_2, NO_x, CO, CO_2) is inevitable during the operation of construction mechanization and vehicles. Noise and vibration will be generated by the construction machinery during construction activities. Different waste types can be expected to be generated during the works: (1) hazardous waste (used waste oil from machinery), non-hazardous (wood, paper, glass, plastic) and domestic waste. Earthworks might cause some temporary pollution to the receiving rivers through increased sedimentation due to (accidentally) discharged suspended solids. The clearing of existing vegetation during preparatory works will result in a loss of associated ecological habitats and their fauna, within the footprint of the development (the site and its surroundings, assess road).

6.3.1.1 Excavation Material

Impact: During the construction phase of the Project, excavation waste will be generated during site preparation and excavation of foundations of structures.

Magnitude: both WWTP sites. Both sites have the same estimated construction period and scope. Transport requirement of excavation material can be expected as comparable.

At Chunga WWTP, here the sludge drying beds and lagoon and the Garden ponds excavation material due to the long term operation of the sites excavation material could be contaminated and cannot be recycled and needs to be disposed safely.

6.3.1.2 Demolition Material

Impact: Demolition will be required to clear the work site. During the construction phase of the Project, demolition material will be generated as a result of dismantling current structures at Manchinchi, Chunga and/or Ngwerere WWTPs.

There is the risk that materials from demolition are hazardous or cannot be recycled and need to be disposed safely.

Magnitude: all WWTPs with higher significance to Manchinchi and Chunga WWTPs. The existing Ngwerere pond system is a concrete structure without any mechanical and/or technical equipment.

At Manchinchi WWTP a plot of 2.3 hectares covering the faecal sludge acceptance and transfer station is proposed to be rehabilitated (buildings and equipment); thus the volume of demolition waste will be low.

6.3.1.3 Domestic Solid Wastes

Impact: Solid waste that may be generated during construction and operational phases comprises the domestic solid waste from workers, packaging waste and excavation material from construction works.

The volume of domestic solid waste generation can be estimated via the number of employees to be working in the construction and operational phases, respectively. Solid waste generation is assumed to be 1.3 – 1.5 kg/cap-day.

Magnitude: New Ngwerere and New Chunga WWTPs: As both options are considered employing an equal number of workers and have the same estimated construction period solid waste generation can be expected as comparable.

Manchinchi WWTP: Solid waste generation would be limited to the demolishing period and the subsequent rehabilitation of the faecal acceptance and transfer station.

Garden ponds: Solid waste generation would be limited to the demolishing period.

6.3.1.4 Liquid Wastes

Impact: During the construction phase of the project options, wastewater will be generated from the construction activities and daily water consumption of the constructional staff.

Drinking and potable water will be required for usage by construction staff and for construction activities such as dust suppression, concrete preparation etc. during the construction phase of the project.

Drinking water demand during the construction and operational phase will be supplied from the market and potable water will be supplied from the public water supply system. As a result of water usage in the construction and operational phase, domestic wastewater will be generated by staff. Roughly estimated per capita water usage can be assumed to be 130-150 l/person-day.

Domestic wastewater generated during the constructional phase of the project will be discharged directly to the public sewer system. During the operation, wastewater will be treated in the WWTP, and discharged into the respective receiving river.

Magnitude: Reference is made to the previous Chapter.

6.3.1.5 Hazardous Wastes

Hazardous waste licences are provided for under Part IV in Section 19 of the Environmental Management (Licensing) Regulations of 2013 - Statutory Instrument (SI) 112 of 2013. Each licence issued by ZEMA is guided by specific conditions that are developed by the regulator. These conditions operationalise the respective hazardous waste licences and are explicit to the type of hazardous waste to be handled. Nonetheless, some general obligations and conditions are contained in the Environmental Management (Licensing) Regulations of 2013.

Main types of hazardous wastes to be generated in the construction and operational phases of the project are oil and air filters, which are changed during maintenance of construction and operation machinery (e.g. bulldozer, excavator etc.), waste fabrics used in maintenance, empty paint and lubricant boxes. Besides these, there may be also hazardous wastes resulting from fluorescent lamps and wasted printer cartridges.

Hazardous wastes to be generated within the project site during construction and operation activities will be collected in temporary hazardous waste storage area, which is surrounded by wire fences, bottom-sealed, and protected from precipitation. Hazardous waste will not be stored for more than 180 days. These stored wastes will be given to the firms licensed for collection of hazardous waste. Hazardous waste collected from the project site will be transferred to licensed intermediate storage areas, and then to hazardous waste landfills or incineration plants for final disposal.

There are a total of about 10 companies licenced by ZEMA to handle hazardous waste. A total of about 60 percent of the licenced companies are involved in handling and transportation of hazardous waste while 40 percent are involved pre-treatment and treatment of hazardous waste.

Magnitude: Reference is made to the previous Chapter.

6.3.1.6 Waste Oil

Impact: Construction machines, trucks and cars are the sources of waste oil in construction and operational phases.

Magnitude: Reference is made to the previous Chapter.

6.3.1.7 Gas Emissions

Impact: During the construction phase of the project, there will be air emissions due to exhaust gas of vehicles and construction machinery. There will be no other fuel consumption other than diesel within the context of the project. Mass flow rate of pollutants are calculated assuming that hourly fuel consumption rate of vehicles and machinery is anticipated as 50 l during the construction activities.

Estimated emission factors and emission amounts for pollutants emitted from diesel vehicles are given in Table 6-16 along with the related limit values allowing a rough calculation of gas emissions as soon as the number of machinery is available.

Magnitude:

New Ngwerere WWTP: Due to massive earthworks and connected transport activities along the access road to the Silvia Masebo Compound gas emissions will have adverse impacts to the population living along this road, but also in the wider periphery. These impacts are more drastic as long as the access road is not paved. Winds in direction to the Compound might further cumulate these effects.

New Chunga WWTP: Due to massive earthworks and connected transport activities along gas emissions will have adverse impacts to the population living directly at the site (along the western border), but also in the wider periphery. Winds in direction to the settlement might further cumulate these effects.

Manchinchi WWTP: Gas emissions would be limited to the demolishing period and the subsequent rehabilitation of the faecal acceptance and transfer station. Emission generating activities are expected to move along the site with focus on massive structures to be demolished (basins, gas holding tanks, foundations).

Garden ponds: Significant gas emissions are expected during the decommissioning period, here the excavation of settled faecal sludge. This material needs to be transported; in return re-filling material needs to be transported and incorporated. Emission generating activities are expected to move along the site (8 individual ponds covering a total area of 44 hectares).

Table 6-16: Emission factors and amounts of pollutants emitted from diesel vehicles

Pollutant	Emission factor	Emission amount	Limit values
	kg/t	kg/hour	
Carbon monoxide	9.7	0.420	50,000
Nitogen oxides	36	1.558	4,000
Sulfur oxides	6.5	0.281	6,000
Dust	18	0.779	1,500

Source: Muezzinoglu, A. (1987): Principles of Air Pollution and Control. - Dokuz Eylul Universitesi Yayinlari

6.3.1.8 Dust Emissions

Impact: The construction activities that may generate dust are listed below.

- Transport on unpaved roads,
- Transport of excavated / demolished material,
- Site preparation and excavation works, and
- Transport, utilization and storage of construction materials.

Table 6-17 is providing a simple model allowing the rough calculation of dust emission resulting from construction activities. As soon as the soil volumes to be transported or moved are known an initial calculation can be undertaken to determine suspended and settleable dust concentrations.

Magnitude: Reference is made to the Chapter before.

Table 6-17: Dust emission factors

Sources	Emission factor	
	min	max
Excavation	0.0125 kg/ton	0.025 kg/ton
Loading	0.005 kg/ton	0.010 kg/ton
Transportation (total return distance)	0.35 kg/km-vehicle	0.7 kg/km-vehicle
Unloading	0.005 kg/ton	0.010 kg/ton

Source: Turkish Regulation on Control of Industrial Air Pollution (RCIAP) - Annex-2, modified

6.3.2 Environmental Impacts during Operation Phase

In the previous chapter environmental impacts during WWTP construction have been addressed. This chapter is making reference to possible environmental impacts specific to the WWTP operation phase. This includes the following main activities:

- treatment technology/ operation of the equipment for sewage treatment and effluent production aiming at preventing WWTP malfunction;
- removal and disposal of grit material;
- effluent discharge to the receiving waters; and
- sludge removal, treatment and final disposal.

6.3.2.1 Malfunction of Treatment Systems

Impact: WWTP malfunction: In view of the nearby settlements a malfunction of the complex process steps in the wastewater treatment line as well as in the sludge line would result in generation of smell due to incomplete degradation processes and release of smelling by-products which might affect the residents significantly. Further risks are non-compliance with the effluent standards for reuse in irrigation. Another important impact of a possible malfunction would be the risk of releasing methane, an effective greenhouse gas.

Magnitude: Trickling filter technology is already known to the LWSC operational staff. In case of power cut offs the system needs to be by-passed with impacts on the effluent quality and generation of smell.

6.3.2.2 Removal and Disposal of Grit Material

Impact description: Generation of treatment process related waste is one of the main negative environmental impacts of the WWTP operation. It has both direct and indirect environmental effects. Direct effects are related to generation of several types of waste and/or grit material. Indirect effects (noise, air emission) are the result of waste transport.

The waste types are identified according to theirorigin. During the preliminary treatment of wastewater the following waste types will be generated:

- Rough waste from coarse screening will be generated regularly after the (automatic) cleaning of the coarse screen. It will comprise rags, paper, plastics, and metals, screened to prevent damage and clogging of downstream equipment and piping.
- Fine screening waste will comprise smaller parts such as sand, broken glass, silt and pebbles. If these objects are not removed, they can damage pumps and other mechanical devices. These objects also have a tendency to settle in corners and bends, thus reducing flow capacity and eventually clogging pipes and channels.

Usually this type of screening material is considered as non-hazardous; thus should be finally disposed at the City's solid waste dump.

- Grit collected in the grit chamber is generally inert in nature, low in organic content and non-hazardous.
- Grease collected in the aerated grit chamber is usually considered as hazardous and needs to be stored and disposed according to the legal requirements or after consultations with ZEMA.

Magnitude: New Ngwerere and new Chunga WWTPs both systems based on trickling filter technology.

6.3.3 Socio-economic Impacts during Construction Phase

Social impacts during construction are presented in Table 6-18, which should be read in conjunction with Annex 4: Protocols of Community Meetings. The assessment has taken into consideration the public consultations and individual meetings with the Ward Counsellors (see Chapter 5.4 'Socio-economic Environment') which took place during September and October 2015.

Table 6-18: Socio-economic impacts during construction phase of Option 5

Location	Impact	Magnitude
Safeguard: Community life, particularly rights and interests of residents, especially vulnerable population groups		
Manchinchi site and Garden ponds	• Vulnerable groups (children and women) in the community are at risk to experience sexual harassment from construction workers • All residents are at risk to experience traffic accidents due to increased traffic with heavy trucks and equipment • Opportunity for LWSC and WDC to develop joint actions for improved living conditions and acceptance of remaining WWTP components	Neighbouring residents
New Chunga WWTP	• Vulnerable groups (children and women) in the community are at risk to experience sexual harassment from construction workers • All residents are at risk to experience traffic accidents due to increased traffic with heavy trucks and equipment • Opportunity for LWSC and WDC to develop joint actions for improved living conditions.	
New Ngwerere WWTP	• Vulnerable groups (children and women) in the community are at risk to experience sexual harassment from construction workers • All residents are at risk to experience traffic accidents due to increased traffic with heavy trucks and equipment • Potential resettlement of estimated 20 – 30	

Location	Impact	Magnitude
	households along the access road will impact significantly on community life • Opportunity for LWSC and WDC to develop joint actions for improved living conditions.	
Safeguard: Involuntary resettlement and social and economic consequences arising from changes in the use of land		
Manchinchi site and Garden ponds	• Not applicable	
New Chunga WWTP		
New Ngwerere WWTP	• Construction of access road requires at least temporary resettlement of 20 – 30 households	20 – 30 households in Silvia Masebo Compound
Safeguard: Community and occupational health, security and safety		
Manchinchi site	• Noise, dust, risk of road accidents during WWTP demolition and re-construction of the faecal sludge acceptance station.	Ngwerere Ward
Garden ponds	• Noise, dust, risk of road accidents during demolishing and de-sludging of the ponds	
New Chunga WWTP & New Ngwerere WWTP	• Noise, dust, risk of road accidents during demolition of existing structures and re-construction. • Increased solid waste accumulation due to construction activities • Increased noise level due to construction, heavy equipment and increased truck traffic • Children are at risk to suffer accidents with heavy equipment and trucks during access road construction and ensuing increased road traffic; during WWTP construction children are at risk due to their own curiosity to play on the construction site • Old people are at risk to suffer respiratory diseases due to increased dust in the air, and road accidents due to increased traffic • Security and safety of the entire community is at risk due to influx of strangers • Work accidents	Mwambeshi Ward Silvia Masebo Compound

Location	Impact	Magnitude
Safeguard: Labour standards		
Manchinchi site and Garden ponds	• Risk of child labour during construction; risk of discrimination in professional life and at the workplace, and risk for freedom of association	Ngwerere Ward
New Chunga WWTP		Mwambeshi Ward
New Ngwerere WWTP		Silvia Masebo Compound
Safeguard: Stakeholder participation and engagement		
Manchinchi site and Garden ponds	• As per SEP and ESMP: enhanced information on, and communication about the project	Ngwerere Ward
New Chunga WWTP		Mwambeshi Ward
New Ngwerere WWTP		Silvia Masebo Compound

6.3.4 Socio-economic Impacts during Operation Phase

Corresponding to the chapter before, social impacts during operation are presented in Table 6-19, which should also be read in conjunction with Annex 4: Protocols of Communiy Meetings. The assessment has taken into consideration the public consultations and individual meetings with the Ward Counsellors which took place during September and October 2015.

Table 6-19: Socio-economic impacts during operation phase of Option 5

Location	Impact	Magnitude
Safeguard: Community life, particularly rights and interests of residents, especially vulnerable population groups		
Manchinchi site and Garden ponds	• Important environmental and health improvements for people living in vicinity of the remaining WWTP structures and former ponds	Ngwerere Ward
New Chunga WWTP	• Community together with LWSC having the opportunity to improve environmental and individual sanitation	Mwambeshi Ward
	• Job creation for skilled and unskilled workers	
New Ngwerere WWTP	• See new Chunga WWT, and in Ngwerere site community life affected by possible need for resettlement and loss of agricultural soils; if extension of WWTP stretches towards the settlement area. • Opportunity for local jobs	Silvia Masebo Compound

Location	Impact	Magnitude
Safeguard: Involuntary resettlement and social and economic consequences arising from changes in the use of land		
Manchinchi site and Garden ponds	• Not applicable	Ngwerere Ward
New Chunga WWTP		Mwambeshi Ward
New Ngwerere WWTP	• Vegetable fields and agricultural plots affected by installation and extension of WWTP; houses have to be removed for maintaining adequate access road	20 – 30 households in Silvia Masebo Compound
Safeguard: Community and occupational health, security and safety		
Manchinchi site and Garden ponds	• Improvements for environment and public health	Ngwerere Ward
New Chunga WWTP	• Potential for achieving Community's expectation for improved sanitation and living conditions, and LWSC's need for sewer connections • Less mosquitoes, less illegal wastewater fetching for irrigation, reduced waterborne diseases	Mwambeshi Ward
New Ngwerere WWTP	• Less mosquitoes, no illegal wastewater fetching for irrigation, reduced waterborne diseases • (Involuntary) resettlement required, although currently the extent is not yet determined • With this WWT technology less households would be requested to move • Loss of agricultural soils: economic value of natural resources, and resources	Silvia Masebo Compound
Safeguard: Labour standards		
Manchinchi site and Garden ponds	• Reduced / avoided risk of discrimination in professional life and at the workplace, and for freedom of association through training of LWSC staff in labour standards *(no child labour, no discrimination in professional life and at the workplace, freedom of association)*	Ngwerere Ward
New Chunga WWTP		Mwambeshi Ward
New Ngwerere WWTP		Silvia Masebo Compound
Safeguard: Stakeholder participation and engagement		
Manchinchi site and Garden ponds	• As per SEP and ESMP	Ngwerere Ward

Location	Impact	Magnitude
New Chunga WWTP		Mwambeshi Ward
New Ngwerere WWTP		Silvia Masebo Compound

6.3.5 Conclusion and Summary of Option 5 – The Preferred Option

6.3.5.1 Summary of Impacts (Impact Matrix)

The following Table 6-21 and Table 6-22 summarize the evaluation of the benefits and impacts to be expected for Option 5, here divided into the Ngwerere site and Chunga site with regard to their degree of harm, reversibility and duration, both for the construction and the operation phases. Furthermore, it will be indicated if mitigation measures are possible. The rating evaluation has been established as stated in the following Table 6-20.

Table 6-20: Rating scheme for the environmental and socio-economic impact assessment of Option 5

●●	Major negative impact
●	Minor negative impact
---	No impact
○	Minor positive impact
○○	Major positive impact
NR	Not reversible
R	Reversible
ST	Short term
LT	Long term
Y	Yes
N	No
NA	Not applicable

Table 6-21: Ngwerere site - Summary of environmental and socio-economic impacts

	Effects by construction	Effects by operation	Reversibility of the impact	Duration of the impact	Mitigation possible	Explanation
Environmental factors						
Soil						
- loss of top soil	●		R	ST	Y	not relevant until the year 2025; area covered by ponds
- excavation	●		NR	ST	N	in the entire area
- mixing of horizons	●		NR	ST	N	within all excavation areas
- input of pollutants	●	●	NR	ST	Y	possible by spilling of waste, petrol and lubri-cants
- compaction	●		R	ST	Y	by stockpiling and storage of construction material
Surface Water (tributary of Ngwerere River)						
- reduction of organic load		○○	NR	LT	NA	will be reduced due to acceptance of imposed treatment standard
- input of nutrients (N, P)		○	NR	LT	NA	
- catchment area		○	NR	LT	NA	additional (waste-)water transfers from Manchinchi catchment
- stabilisation of flow regime		○	NR	LT	NA	downstream the discharge point
- potential risk of flooding		●	NR	LT	Y	additional (waste-)water transfers from Manchinchi catchment and increased effluent generation may exceed the capacity of the receipient, esp. during the rainy season
Groundwater						
- input of nitrates		○	NR	LT	NA	will be reduced due to acceptance of treatment standard
- input of pollutants	●		NR	ST	Y	during construction by spilling of fuel
Air						
- noise	●●	●	R	ST/ LT	Y	
- other emissions	●		NR	ST	N	exhaust of the vehicles transporting demolition and construction material
Climate / Atmosphere						

	Effects by construction	Effects by operation	Reversibility of the impact	Duration of the impact	Mitigation possible	Explanation
- emissions of CO_2 (equivalents)	NA	●	NA	LT	NA	future WWTP has higher energy consumption as the existing pond system
- other emissions	●	●	NR	ST	N	exhaust of the vehicles transporting (demolition and construction) material
Flora, Fauna & Biodiversity						
- terrestrial biotope structures	---	---				replacement of existing ponds
- fauna (birds, fish, insects)	●	●	NR	ST / LT	N	demolition of pond system will impact observed fauna
Cultural Goods						
- archaeological sites	---	---	NA	NA	NA	no sites identified
Socio-economic factors (safeguard)						
Community Development and Land Use						
- loss of agricultural land	●		NR	LT	Y	not relevant in the year 2025
- job creation	○○	○	R	ST / LT	NA	for skilled and unskilled workers
Resettlement						
Up to year 2025: - economic displacement (land and assets)	●●		NR	LT	Y	(temporary) resettlement is required along the access road to the WWTP (~ 20-30 families), legal land acquisition / compensation procedure to be applied
Reference year 2040: - economic displacement (land and assets)		●●	NR	LT	Y	WWTP extension of 10 ha requires resettlement of ~ 20-30 families, legal land acquisition / compensation procedure to be applied
Health & Safety						
- health of workers	●		R	ST/ LT	Y	air pollution and handling of untreated wastewater or sludge may affect health of the workers
- Increased solid waste accumulation	●		R	ST	Y	support community with road safety education, health services and security measures
- Children are at risk to suffer accidents	●		R	ST	Y	

	Effects by construction	Effects by operation	Reversibility of the impact	Duration of the impact	Mitigation possible	Explanation
- Old people and children are at risk to suffer respiratory diseases	●		R	ST	Y	
- Security and safety at risk due to influx of strangers	●		R	ST	Y	
- health of residents and farmers		○○	NA	LT	NA	residents and farmers will have significantly reduced risk of getting water borne diseases
- residents (close to the WWTP)	●	●	NR	ST	Y	visual impacts, noise, smell
		○○	NA	NA	NA	availability of safe effluent
- employment	○○	○	NA	NA	NA	for skilled and unskilled workers
- presence of vectors	●		R	ST	Y	increased solid waste accumulation could potentially lead to higher presence of mosquitoes and vectors
- downstream farmers (close to WWTP)		○○	NR	LT	NA	additional source for irrigation
- farmers		○	NA	NA	NA	availability of safe sewage sludge
- traffic	●●	●	NR	ST	N	heavy trucks during construction; risk of accidents
Labor standards						
- risk of discrimination in professional life		●	R	NA	Y	LWSC staff to be trained in labour standards

Table 6-22: Chunga site - Summary of environmental and socio-economic impacts

	Effects by construction	Effects by operation	Reversibility of the impact	Duration of the impact	Mitigation possible	Explanation
Environmental factors						
Soil						
- loss of top soil	●		R	ST	Y	relevant when the demolishing of the existing WWTP starts
- excavation	●		NR	ST	N	in the entire area
- mixing of horizons	●		NR	ST	N	within all excavation

	Effects by construction	Effects by operation	Reversibility of the impact	Duration of the impact	Mitigation possible	Explanation
						areas
- input of pollutants	●	●	NR	ST	Y	possible by spilling of waste, petrol and lubricants
- compaction	●		R	ST	Y	by stockpiling and storage of construction material
Surface Water (Chunga River)						
- reduction of organic load		○	NR	LT	NA	will be reduced due to acceptance of imposed treatment standard
- input of nutrients (N, P)		○○	NR	LT	NA	
- catchment area	---	---				
- stabilisation of flow regime		○	NR	LT	NA	downstream the discharge point
- potential risk of flooding	---	---				increased effluent generation may exceed the capacity of the receipient, especially during the rainy season
Groundwater						
- input of nitrates		○○	NR	LT	NA	will be reduced due to acceptance of treatment standard
- inputs of industrial wastewater		○	NR	LT	NA	less uncontrolled seepage of industrial wastewater
- input of pollutants	●		NR	ST	Y	during construction by spilling of fuel
Air						
- noise	●●	●	R	ST/ LT	Y	
- other emissions	●		NR	ST	N	exhaust of the vehicles transporting demolition and construction material
Climate / Atmosphere						
- emissions of CO_2 (equivalents)	NA	●	NA	LT	NA	future WWTP has higher energy consumption as existing system
- other emissions	●	●	NR	ST	N	exhaust of the vehicles transporting (demolition and construction) material
Flora, Fauna & Biodiversity						
- terrestrial biotope structures	●	●	NR	LT	N	WWTP site to be fully covered with structures
- fauna (birds, insects)	---	---				

	Effects by construction	Effects by operation	Reversibility of the impact	Duration of the impact	Mitigation possible	Explanation
Cultural Goods						
- archaeological sites	---	---	NA	NA	NA	no sites identified
Socio-economic factors (safeguard)						
Community Development and Land Use						
- loss of agricultural land	---	---				
– Chunga community graveyard		●	NR	LT	Y	WWTP structures may negatively affect grave-yard visibility
	●		R	ST	Y	Graveyard to be protected against short term impacts (demolition and reconstruction works)
- job creation	○○	○	R	ST / LT	NA	for skilled and unskilled workers
Resettlement						
- economic displacement (land and assets)	---	---				
Health & Safety						
- health of workers	●		R	ST/ LT	Y	air pollution and handling of untreated wastewater or sludge may affect health of the workers
- Increased solid waste accumulation	●		R	ST	Y	support community with road safety education, health services and security measures
- Children are at risk to suffer accidents	●		R	ST	Y	
- Old people and children are at risk to suffer respiratory diseases	●		R	ST	Y	
- Security and safety at risk due to influx of strangers	●		R	ST	Y	
- health of residents (and farmers)		○○	NA	LT	NA	residents will have significantly reduced risk of getting water borne diseases; currently less farming activities around the WWTP site
- residents (close to the WWTP)	●	●	NR	ST	Y	visual impacts, noise, smell
		○	NA	NA	NA	availability of safe effluent
- employment	○○	○	NA	NA	NA	for skilled and unskilled workers

	Effects by construction	Effects by operation	Reversibility of the impact	Duration of the impact	Mitigation possible	Explanation
- presence of vectors	●	□	R	ST	Y	increased solid waste accumulation could potentially lead to higher presence of mosquitoes and vectors
- downstream farmers (close to WWTP)		○	NR	LT	NA	additional source for irrigation, but currently less farming activities around the WWTP site
- farmers		●	NA	NA	NA	sewage sludge not suitable for agricultural reuse; proper manage-ment of industrial discharger required
- traffic	●	●	NR	ST	N	heavy trucks during WWTP demolition and re-construction; risk of accidents
Labor standards						
- risk of discrimination in professional life		●	R	NA	Y	LWSC staff to be trained in labour standards

6.3.5.2 Overall Assessment and Conclusion

Finally, after having elaborated the benefits and impacts to be expected for Option 5, an overall assessment summarizing the advantages and disadvantages with regard to all concerned sites is presented. Hereto the following Table 6-23 is making reference to general (primarily technical), environmental and social aspects.

Table 6-23: Summary assessment of wastewater treatment Option 5

Advantages	Disadvantages
General	
In addition to Chunga and Manchinchi, this Option also treats the wastewater from the Ngwerere catchment.	All WWTPs: Intensive safeguard measures to be implemented as WWTP demolition and/or construction and operation takes place in densely populated environment (noise, smell, visual impacts etc.)
All disposal of sludge to be catered for outside city centre.	Potential transfer of significant (waste-)water volumes from Manchinchi to Ngwerere catchment. Transfers will impact the water balances, but also customary water rights.

Advantages	Disadvantages
Same wastewater technology as previously applied on Chunga and Manchinchi WWTPs, which is known to LWSC. Introduction of chlorination to reduce area requirements.	
Chosen wastewater treatment technology provides gas utilisation from sludge treatment with the possibility of future extensions into electricity production.	
Closure of Manchinchi WWTP and Garden Ponds	
Closure of Manchinchi WWTP* and Garden Ponds will have an important environmental and health impact for people living in vicinity of the sites.	Decommissioning/de-sludging of the Garden Ponds will cause higher levels of disturbance (noise, smell), but will be limited to a short period.
Creation of job opportunities, especially for unskilled workers during the demolition/de-sludging phases.	
Significant wastewater volumes treated outside of the urban city center with positive impacts on health and security conditions for residents esp. neighbouring Manchinchi WWTP.	
New Chunga WWTP	
During the dry season effluent discharge in the receiving water (Chunga River) will have significant dilution effects. Effluent flow will benefit to the down-stream communities.	Risk of heavy metal contamination of the sludge, in case Trade Effluent Standards are not fully enforced (like at present)
WWTP can be accommodated within the existing sites; no additional land acquisition required.	High risk to public health, if sludge is used in agricul-ture. This behaviour cannot be excluded, because the WWTP is surrounded by agricultural land and small holders, some of them already collect sludge for its reuse as soil improver, although this practise is illegal.
No (involuntary) resettlement is required.	Fast growing residential settlement bordering to the WWTP site requires intensive environmental and social safeguard measures during all project phases (demoli-tion / re-construction / operation).
Creation of job opportunities for skilled and unskilled workers during all project phases (demolition / con-struction / operation) as well as economic and social development.	Community graveyard located along the access road to the WWTP site to be protected against short term impacts (demolition / reconstruction works) and long terms affects (visibility of WWTP structures).
No (waste-)water transfers to other catchments.	
New Ngwerere WWTP / Silvia Masebo Compound	
Potential safe reuse of treated wastewater for ferti-irrigation purposes by local farmers.	During dry season receiving water has no flow up-stream of effluent, i.e. no dilution will take place.
Year 2025: WWTP can be accommodated within the existing site.	It is a risk that smell, noise, increased traffic and solid waste will create neighbourhood conflicts
Creation of job opportunities for skilled and unskilled workers during all project phases (demolition / con-struction / operation) as well as economic and social development.	Up to the year 2025: Construction/broadening of the road and traffic during construction will require moving of about 20-30 households; farmers in Silvia Masebo Compound will have to abandon their vegetable fields in direct vicinity to the WWTP - at least during construction period.

Advantages	Disadvantages
	Year 2040: WWTP extension requires moderate additional land acquisition of about 10 ha. This process can be associated with the potential resettlement of up to 20 households.
	During rainy season, potential risk of flooding due to unsufficient capacity of the receiving water not investi-gated yet.
Wastewater transfer pipeline from Manchinchi WWTP to Ngwerere site	
Construction of new pipeline in correct dimension (replacement of existing DN 300/600 sections by DN 900) likely to reduce blockages and overflows.	Some sections are in close proximity to existing residential houses (CSU-07, between M 132 - M 118) or houses are directly built on the proposed pipeline course (between M 107 - M 101; M 97 - M 76). Re-routing of the pipeline has to be considered to avoid resettlement and compensation.
Creation of job opportunities, especially for unskilled workers during the construction phase.	Massive disturbance of residents, public roads and traffic flows during construction phase is likely.

* - 2.3 ha remaining for faecal sludge acceptance and transfer station

7 MITIGATION MEASURES

Responding to the environmental and social impacts described in the chapter before, detailed mitigation measures have to be identified and evaluated in order to avoid, reduce or remedy the impacts from the wastewater treatment systems during both phases, construction and operation. In this context reference is exclusively made to the preferred **Option 5 with specific reference to the New Ngwerere and New Chunga WWTP sites.**

In the Chapter 6, environmental and social impacts associated with Option 5 have been presented. Thus, this chapter provides a summary of detailed mitigation measures specified in tabular form.

7.1 Environmental Mitigation Measures during Construction

The mainly short-term negative environmental impacts, which inevitably occur during the demolition of existing structures and the WWTP' reconstruction, will be minimized by proper planning and application of preventive measures, and will be mitigated by restorative actions after the civil works are completed as listed in Table 7-1.

In practise, proper planning means that mitigation measures become integrative part of the final design to be submitted by the construction contractor and have to be approved by the competent authoritiy/ies prior to any construction works.

Table 7-1: Environmental mitigation measures during construction of wastewater treatment Option 5

Environmental media	Impacts	Mitigation measures
Physical Environment		
Soils	• Damage to soil structure due to material storage, construction traffic, etc. • Loss of topsoil during excavation for/ disposal of construction materials • Erosion due to uncontrolled surface run-off • Pollution at discharge point, possibly leading to groundwater pollution	• Protect non-construction areas, avoid work in sensitive areas during highly adverse conditions, provide temporary haul roads as appropriate, restore damaged areas • Strip topsoil where necessary, store and replace post construction • During storage, surface of top soil will be grassed and stored separately from other excavation earth • Design drainage and other disposal facilities to ensure soil stability and appropriate treatment

Environmental media	Impacts	Mitigation measures
Land	• Land degradation	• Design works to minimize land affected • In general, space occupied by vehicles, machines and storage of excavation and construction material should be minimised • Protect / separate non-construction areas
Water Resources (Chunga River and tributary of Ngwerere River)	• Contamination/pollution from construction, human and animal wastes, including fuel & oil, hazardous wastes, wastewater and sewage – especially from discharge if not connected to existing sewer. • Changes in flow regime from excavation for/disposal of soil, waste materials, etc. • (Additional) eutrophication of surface water leading to habit changes, etc.	• Establishment of waste collection / storage / separation point • Hazardous wastes will be collected in temporary hazardous waste storage area, which is surrounded by wire fences, bottom-sealed, and protected from precipitation. • Non-hazardous waste generated at the plant will be regularly removed, temporarily collected and finally disposed at the City solid waste landfill • Close to the river no material deposits should be permitted and no re-fueling / lubrication of vehicles • Design (wastewater) drainage system to avoid run-off and spillage • Site treatment works appropriately, or incorporate into larger wastewater systems, provide any treatment necessary to meet required standards, plus training
Air Quality	• Dust and fumes during demolishing and construction • Gas emissions as exhaust gas of vehicles and construction machinery • Generation of smell during excavation of the Garden ponds.	• Appropriate design • Control construction methods and plant, timing of works • New Ngwerere WWTP: Pavement / widening of access road to Silvia Masebo Compound • Dust control by water-spraying of roads, surfaces prior to being worked, and material stockpiles to increase dust raising, as required especially during dry seasons • Restrict vehicle speeds in/along residential areas • Proper operation, monitoring system in place
Noise	• Noise disturbance from construction works and traffic	• Establishment of agreed site working hours for “normal” construction activities • Use appropriate construction methods & equipment • Use of attenuation measures such as silencers/enclosures, where appropriate • Machinery will be well maintained and be turned off when not in use • Restrict vehicle speeds in/along residen-

Environmental media	Impacts	Mitigation measures
		tial areas, especially trucks • Restrict level of noise not higher as 55 dB during day time and not higher than 45 dB during night activities (if any).
Biological Environment		
Natural Habitats	• Disturbance of natural habitats during and post construction • Changes due to eutrophication of Chunga/Ngwerere Rivers due to temporary missing of natural flow regime	• Careful siting/design of structures and/or timing of works (seasonal)
Fauna and Flora	• Impact on presence of birds, fish and aquatic insects due to demolition of pond system at Ngwerere • No endangered or protected species were identified during flora / fauna audits • Minor loss of vegetation during construction	• No mitigation possible for loss of pond system

7.2 Environmental Mitigation Measures during Operation

During operation of the WWTPs mitigation measures in order to avoid or minimise negative impacts on air quality and noise levels are to be implemented. Another task is focusing on technological aspects, mainly achieving effluent and sludge qualities in accordance with imposed standards. Complying with these tasks is primarily subject to proper planning processes, thus clearly reflected in the next Table 7-2.

Table 7-2: Environmental mitigation measures during operation of wastewater treatment Option 5

Environmental media	Impacts	Mitigation measure
Water resources (Chunga River, tributary of Ngwerere River)	• Water transfer from Manchinchi to Ngwerere catchment and associated impact on customary and legal water rigths • Treated effluent quality problems • WWTP malfunctioning • Possible overflows of untreated or imperfectly treated wastewater to the Chunga/Ngwerere Rivers • Ngwerere River: During the rainy season significant wastewater transfer from Manchinchi catchment in combination with increaseing effluent generation may exceed the capacity of the receiver. Chunga River: capacity might be a limiting factor linked to the risk of flooding during the rainy season, due to significantly increasing effluent generation.	• Customary and legal water rigths to be investigated and assessed • Wastewater treatment acc. To Zambian standard • Regular monitoring of effluent quality • Capacity building, training and awareness of WWTP management and operational staff • In case of accidental failure or malfunction respective users of the effluent for irrigation should be informed in order to increase their safety measures to avoid any health risk • Provision of generator set • Flood risk: additional investigations required (flow regime, river morphology)
Soils	• Sludge quality and potential risks to the public and farmers • Accumulation of heavy metals	• Sludge treatment acc. to standard to be defined/imposed • Design and implementation of Sludge Management Plan / Procedure • Sludge storage in drying beds for min. 6 months following digestion and dewatering • Regular monitoring of agricultural parameter (nutrients) and heavy metal concentration • Regular monitoring of sanitary quality (coliforms, pathogens) of treated sludge • Transportation of treated sludge in closed containers • Capacity building, training and awareness raising campaigns to WWTP staff and potential user
Landscape (visual impacts)	• Negative effects of technical buildings in a mainly rural environment	• Planting of trees and ornamental plants, where appropriate.

Air quality / emissions	• Odour nuisance generation	• Careful planning and implementation of operation and maintenance • Non-hazardous waste generated at the plant will be regularly removed, temporarily collected and finally disposed at the City solid waste landfill • Proper operation of the faecal acceptance stations • Providing covers to equipment and containers that are likely to cause odour nuisance (sludge, waste, grit material) • Screens will be cleaned regularly. Transport of screenings / grit material is to be carried by closed-top trucks • Plantation around the WWTP site
Natural habitats / Flora & Fauna	• Impact on presence of birds, fish and aquatic insects due to demolition of pond system at Ngwerere	• No mitigation possible
	• Effluent impact the habitat of the Ngwerere River	• Regular monitoring of effluent quality

7.3 Socio-economic Mitigation Measures during Construction

During the demolition of the existing structures and the reconstruction of the WWTPs mitigation measures in order to avoid or minimise a variety of negative impacts as indicated in Table 7-3 are to be implemented.

Table 7-3: Socio-economic mitigation measures during construction of wastewater treatment of Option 5

Socio-economic safeguards	Impacts	Mitigation measures
Community life, particularly rights and interests of vulnerable population groups	• Vulnerable groups (children and women) in the community are at risk to experience sexual harassment from construction workers • All residents are at risk to experience traffic accidents due to increased traffic with heavy trucks and equipment • Potential resettlement of estimated 20-30 households at Ngwerere site will impact significantly on community life	• Train local Women Association, school teachers and parents together with WDC / Community Development Committee in self-protection measures in conjunction with the Road Transport and Safety Agency (RTSA) • Refer to Resettlement Policy Framework outline in the attachment; and elaborate a social appropriate Resettlement Action Plan

Socio-economic safeguards	Impacts	Mitigation measures
Involuntary resettlement and social and economic consequences arising from changes in the use of land	• (Involuntary) resettlement at Ngwerere site needed due to construction of • (1) Access road to construction site, and • (2) WWTP and future extension • To (1): Current estimation counts about 25 households (average household size: 8.33 persons; resulting in about 208 affected residents) directly physically affected by the construction of the access road • To (2): In case the additional land for the WWTP terrain will be extended towards the Silvia Masebo Compound in the North-Eastern neighbourhood of the WWTP, about 20 30 households have to be moved out of their current location. About 20 vegetable producers will lose their economic base (soil and irrigation water) • To (3): Fence re-construction / protective wall construction will put barrier against the use of irrigation water for agricultural activities	• Refer to Resettlement Policy Framework outline (in attachment) • Elaboration of socially accepted Resettlement Action Plan which has to include a Livelihood Restoration Plan
Community health, security and safety and occupational health and safety	• Increased solid waste accumulation due to construction activities • Increased noise level due to construction, heavy equipment and increased truck traffic • Children are at risk to suffer accidents with heavy equipment and trucks during access road construction and ensuing increased road traffic; during WWTP construction children are at risk due to their own curiosity to play on the construction site; • Old people are at risk to suffer respiratory diseases due to increased dust in the air, and road accidents due to increased traffic • Security and safety of the entire community is at risk due to influx of strangers • Work accidents	• Support community with road safety education, health services and security measures; • Hire local labour; • Tender documents should highlight the importance of occupational health and safety measures • OHS Plan to be elaborated by the Contractor • Health and Safety • Officer to monitor conditions on site

Socio-economic safeguards	Impacts	Mitigation measures
Labour standards	• Risk of child labour, of discrimination in professional life and at the work-place, and for freedom of association	• In order to avoid negative impacts during construction, tender documents have to highlight labour standards as pre-condition for bidder's qualification (no child labour, no discrimination in professional life and at the workplace, freedom of association)
Stakeholder participation and engagement	• Information and communication on the project	• As per SEP and ESMP

7.4 Socio-economic Mitigation Measures during Operation

It is important to acknowledge that today's characteristics of Silvia Masebo Compound in terms of size, population, and livelihood is primarily the 'product' of the existence of the ponds. The availability of water (here: effluent) has shaped the socio-economic conditions. If the ponds will be demolished, it will have a major impact on the community.

During operation of the WWTPs mitigation measures in order to avoid or minimise a variety of impacts as indicated in Table 7-4 are to be implemented.

Table 7-4: Socio-economic mitigation measures during operation of wastewater treatment of Option 5

Socio-economic safeguards	Impacts	Mitigation measures
Community life, particularly rights and interests of indigenous people and other vulnerable population groups	• In Ngwerere site, community life affected by possible need for resettlement and loss of agricultural soils; if extension of WWTP stretches towards the settlement area. • Opportunity for local jobs	• Social acceptable Resettlement Action Plan • Support to local associations, esp. Women Association • Include in WWTP design and layout plan access point to treated effluent for small-scale irrigation
Involuntary resettlement and social and economic consequences arising from changes in the use of land	• (Involuntary) resettlement required, although currently the extent is not yet determined. • With this WWT technology less households would be requested to move. • Loss of agricultural soils: economic value of natural resources, and resources for local and national food security	• Elaboration of socially accepted Resettlement Action Plan which has to include a Livelihood Restoration Plan • Identify other / comparable area for agricultural activities to ensure local and national food security

Socio-economic safeguards	Impacts	Mitigation measures
Community and occupational health, security and safety	• Increased traffic • Improved health situation due to less mosquitoes and vectors • Risk of occupational accidents • (Reduced) application of (treated) wastewater for irrigation	• Health and hygiene education in schools and through local associations to the entire community; • Creation of and support to local health and environmental services • LWSC staff training in occupational health and safety measures according to organizational policy since 2013 • Agricultural training with local farmers for correct application of treated wastewater / effluent on fields • Safe sanitation systems for residents
Labour standards	• Risk of discrimination in professional life and at the workplace, and for freedom of association	• LWSC staff has to be trained in labour standards (no child labour, no discrimination in professional life and at the workplace, freedom of association)
Stakeholder participation and engagement	• Information and communication on the project	• As per SEP and ESMP

8 ENVIRONMENTAL AND SOCIAL MANAGEMENT PLAN AND MONITORING

The Environmental and Social Management Plan identifies measures to address any environmental and socio-economic impacts that might occur during the construction and operation of the implementation of **Option 5, here with specific reference to the new Ngwerere and Chunga WWTP sites.** Hereto the ESMP covers mitigation measures, monitoring and institutional strengthening.

The objective of this ESMP is to ensure the integration of environmental and social issues and proposed mitigation into the detailed design and implementation. To achieve satisfactory implementation of construction works and operation of the WWTP, the ESMP is aiming that:

(a) implementation is monitored; (b) adverse environmental and social impacts are mitigated; and (c) implementation will meet the requirements of Zambian environmental regulations and donor safeguard policies.

Responding adequately to the complex nature of the envisaged implementation of Option 5 the ESMP is referring to the following issues:

- Environmental Monitoring Plan during WWTP construction
- Environmental Monitoring Plan during WWTP operation
- Social Management Plan during WWTP construction
- Social Management Plan during WWTP operation
- Outline of Draft Resettlement Policy Frameworks (RPF)
- Future Management of Industries

Accepting the overall objectives of the ESIA Study the **ESMP is of preliminary character** and needs to be continuously updated during the further process.

8.1 Environmental Monitoring Plan

The purpose of the Environmental Monitoring Plan will be to monitor compliance with the mitigation measures identified in the chapter before.

Environmental monitoring of **construction activities** will have to ensure that mitigation measures of construction impacts as identified under the chapter before are being implemented properly, while monitoring of **operation activities** is to ensure that no unforeseen negative impacts are arising.

During the operation of the new Ngwerere and Chunga WWTPs environmental monitoring will include physical-chemical analysis on the inflowing wastewater, effluent quality and also the sludge quality.

For an easier follow up of the monitoring activities they have been assembled in tabular form hereafter.

Table 8-1: Environmental monitoring during WWTP construction

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is the responsible for the monitoring?*
Dust	At construction sites	Visual monitoring	Daily	Are environment requirements and defined standards respected?	Contractor Construction supervision team ZEMA
	At Silvia Masebo Compound.	Visual monitoring, Site visits	Weekly	Are environment requirements and defined standards respected? Any complaints from the compound population?	
Noise	- at construction sites - along access road - inside S. Masebo Compound	Portable noise meters	Regularly through site visits	Are imposed standards respected? (day time:55 dB) (night time: 45 dB)	
Wastewater from construction site	At construction sites	Visual monitoring	Regularly through site visits	Are environment requirements and defined standards respected?	
Collection of solid wastes	At construction sites	Visual monitoring	Regularly through site visits	Are environment requirements and defined standards respected?	Contractor Construction supervision team
Disposal of solid wastes	At disposal site(s)	Visual monitoring	Regularly through site visits	Are environment requirements and defined standards respected?	
Collection and storage of hazardous wastes (oil and air filters, empty paint and lubricant boxes, inflammable and toxic materials etc.)	At construction sites and through documentation	Visual monitoring, analysis of documentation	Weekly	Are environment requirements and defined standards respected?	
Disposal of hazardous wastes	At construction sites and through documentation	Visual monitoring, analysis of documentation	Monthly	Is the accumulation of hazardous waste at the construction site prevented? Are imposed standards respected?	Contractor Construction supervision team ZEMA
Construction site protection	At construction site	Visual monitoring	Monthly	Are imposed security	Contractor

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is the responsible for the monitoring?*
activities				requirements respected?	Construction supervision team
Protection of habitats	At construction site	Visual monitoring	Monthly	Are environment requirements and defined standards respected?	Contractor Construction supervision team ZEMA
Restoration of lands damaged by excavation	At construction site	Visual monitoring	At completion of construction process (by sectors)	Are environment requirements and defined standards respected?	Contractor Construction supervision team LWSC
Traffic disruption	At construction sites	Visual monitoring of a) use of designated routes and b) coverage of material transporting trucks.	Regularly through site visits	Are imposed standards respected?	Contractor Construction supervision team

Table 8-2: Environmental monitoring during WWTP operation

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is responsible for the monitoring?*
Noise	- at WWTP sites - inside S. Masebo Compound	Portable noise meters	Acc. to monitoring plan	Are imposed standards respected?	Operator ZEMA
Air quality / emissions		Sampling and analysis	Acc. to monitoring plan	Are environment requirements and defined standards respected?	
Solid wastes disposal	At disposal sites	Visual monitoring	After WWTP commissioning	Are imposed standards respected?	Operator
Grit, oil, grease	At disposal sites	Visual monitoring	After WWTP commissioning	Are imposed standards respected?	Operator
Influent water quality (bacteriological, physical and chemical parameters)	At WWTP inlet	Sampling and analysis	Acc. to monitoring plan	Compliance with Zambian standard?	Operator ZEMA
Influent water quality (industrial impacts such as heavy metals)	At WWTP inlet	sampling and analysis	On demand	Compliance with Zambian standard?	Operator ZEMA
Treated effluent	At WWTP outlet	sampling and	Daily	Compliance with	Operator

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is responsible for the monitoring?*
quality (bacteriological, physical and chemical parameters)		analysis		Zambian standard? Can effluent safely be reused by potential user?	ZEMA MoH
Treated effluent quality (bacteriological, physical and chemical parameters)	Upstream / downstream analysis at defined sampling points	sampling and analysis	Monthly	Compliance with Zambian standard? Are surface water quality parameter achieved?	Operator ZEMA
Sludge quality - standard parameter - agronomic parameter - heavy metals	Drying beds / lagoons	sampling and analysis	Acc. to sludge management plan	Sludge compliance in compliance with defined standard? Is sludge quality allowing safe reuse in agriculture?	Operator ZEMA MoH
Optional: Raw water quality of S. Masebo Compound wells (bacteriological, physical and chemical parameters)	Drinking water wells in the compound	sampling and analysis	Quarterly	Compliance with Zambian drinking water standard? Are there indications of quality impacts caused by the WWTP?	Operator ZEMA MoH

8.2 Social Management Plan

Social management involves the adequate consideration of social variables during the project construction and operation to determine the changes which may have occurred as a result of the project and to determine the effectiveness of the mitigation measures. Respective actions are summarized in the following Table 8-3 andTable 8-4.

Table 8-3: Social monitoring during WWTP construction

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is responsible for the monitoring?*
Rights and interests of community, esp. of	At construction sites and	On-site visits incl. community	Monthly	In order to identify if interest	Contractor

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is responsible for the monitoring?*
vulnerable groups (children, women, old people) incl. safety and security aspects	surrounding	meetings and random interviews to women, old people and children (at school)		and rights of the community are observed and respected	Construction supervision team LWSC
Resettlement and change of land use (compliance with OP 4.12 and Land Law)	At construction sites and surrounding, esp. along the access road and in vicinity to the ponds	Visual appraisal; analysis of documentation; community meetings	At least monthly, depending on Resettlement Action Plan and Livelihood Restoration Plan	In order to check if Resettlement Policy and Action Plan are observed and respected	Construction supervision team LWSC MinLGH
Public Health: road accidents; accidents during construction; increase of other diseases	At surrounding community	On-site visits and communication; interviews with health workers, community leaders and construction enterprise(s)	Monthly	To check if health, safety and security requirements are considered and respected	Contractor Construction supervision team LWSC MoH
Implementation of OHS Plan	At construction site	On-site visits; analysis of documentation (reports); visual monitoring	Daily	To check if health, safety and security requirements are considered and respected	
Labour standards	At construction sites	Visual monitoring through site visits	Regularly, best fortnightly	In order to verify that labour standards are implemented	
Stakeholder participation	In the community	Meetings with community leaders and residents: communication and site visits	Regularly, at least monthly	To check if Stakeholder Engagement Plan is followed	Construction supervision team LWSC

Table 8-4: Social monitoring during WWTP operation

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is responsible for the monitoring?*
Rights and interests of community, esp. of vulnerable groups (children, women, old people) incl. safety	At WWTP site and neighbourhood	On-site visits incl. community meetings and random interviews to women, old	After commissioning of WWTP, and at least every 6th month	To identify if interest and rights of the community and the vulnerable	Operator LWSC safeguard team

What *parameter is to be monitored?*	**Where** *is the parameter to be monitored?*	**How** *is the parameter to be monitored/type of monitoring equipment?*	**When** *is the parameter to be monitored - frequency of measurement or continuous?*	**Why** *is the parameter to be monitored (optional)?*	**Who** *is responsible for the monitoring?*
and security aspects		people and children (at school)		groups are observed and respected	CBOs
Resettlement and change of land use	In Silvia Masebo Compound and new resettlement area(s)	Visual appraisal; community meetings; visits in resettled households	At least monthly, depending on Resettlement Action Plan and Livelihood Restoration Plan	In order to check if Resettlement Policy and Action Plan are observed and respected	Operator LWSC safeguard team CBOs MinLGH
Public Health: road accidents; work accidents at WWTP; development of other diseases **Occupational Health**	In WWTP and Silvia Masebo Compound	Communication and on-site visits; interviews with health workers, community leaders and construction enterprise(s); data analysis from local health centre (if created until then) and / or Mobile Clinic	Regularly – at least every 6th month	To check if health, safety and security requirements are considered and respected	Operator LWSC safeguard team CBOs
Labour standards	In WWTP	Visual monitoring on-site and communication with LWSC safeguard officer	Regularly – at least every 6th month	In order to identify if the labour standards are implemented	
Stakeholder participation	In the community	Meetings with community leaders and residents	Regularly through communication and site visits – after commissioning at least every 6th month	To check if Stakeholder Engagement Plan is followed	

8.3 Outline of Draft Resettlement Policy Framework

The new Ngwerere WWTP has been identified to require the potential resettlement of affected population from the Silvia Masebo Compound. Responding adequately to this situation a Resettlement Policy Framework outline (RPF) has been prepared. In contrast, the demolition/re-construction of Chunga WWTP as well as the implementation of the wastewater transfer pipeline from the Manchinchi WWTP to the new Ngwerere WWTP are not associated with potential impacts necessitating the set up of a Resettlement Action Plan.

The purpose of this specific RPF outline is to provide a guide to addressing land acquisition and resettlement issues in the area of Ngwerere ponds as one considerable impact of the project. The justification for the individual projects being proposed under Option 5 are stated as follows:

- Ngwerere: Re-construction, paving and broadening of the existing access road.

  The implementation of Option 5 will require the **relocation of about 20 to 30 households along the access road** and the change of land use from agriculture to WWTP purposes. Formal land acquisition has to be prepared and carried out as Silvia Masebo Compound has been formalized as residential area in 2008, and the residents are in the process to obtain their documentation as owners of their plots. World Bank policy on Involuntary Resettlement (OP 4.12) is therefore triggered.

- Ngwerere: In the reference year 2040 the extension of 10 ha (total area in the year 2040: ~ 34 ha) of the WWTP area is required, therefore **resettlement and /or compensation for agricultural soil, and about 20 households could then be required.**

  However, it is not yet decided in which direction this extension will take place. In the best case for the residents, the extension area will be chosen to the southern or south-eastern side of the current pond area, thus only affecting those households living along the access road to the WWTP site.

- Chunga: Treatment concept based on trickling filters and anaerobic sludge treatment; entire site of 14 ha owned by LWSC will be included in the concept and protected against neighbors, who (illegally) used the terrain for agricultural activities. **Nonetheless, no resettlement activities are required.**

- Wastewater transfer pipeline from Manchinchi site to Ngwerere site: The investigation of all sections has revealed that there is no requirement for resettlement, except the section crossing Mazyopa Compound (section from manholes M 98 – M 75). However, as proposed by the EIB FS Consultant crossing this section can be avoided by re-routing this pipeline section. **Respectively, applying this measure will avoid the necessity of a Resettlement Action Plan.**

  While undertaking a transect walk along the existing sewer lines, it became obvious that in a number of places the pipeline is below residential houses and commercial buildings. In addition, fibre optic cables, electricity cables and water supply pipes are buried in the ground and require special attention during mechanical trenching of the pipeline extension. However, none of the locations require resettlement as far as the pipeline is concerned. In the case of Mazyopa Compound, moving out of families could be avoided by changing the route of the pipeline towards a still open space.

The principle behind the RPF outline incorporates planning of project activities so as to minimize and/or mitigate resettlement impacts. The herewith presented RPF outline provides for the mitigation of potential resettlement impacts; it allows for the later formulation of subproject specific resettlement screening and Resettlement Action Plans (RAPs), which have to be elaborated in a next phase.

Due to its importance the RPF outline is presented as **corresponding attachment** to this Draft Final ESIA study.

8.4 Future Management of Industries

As indicated in the previous chapters of the study, industries have a significant impact on the inflowing wastewater, effluent and sewage sludge quality. This especially refers to the Chunga WWTP where industrial inflows significantly contribute to the exceeding of a variety of parameters of imposed standards, both in the effluent and sludge. Respectively, proper management of the industrial sector is the key element for future compliance with imposed effluent and sludge standards paving the way forward for responsible sludge reuse.

8.4.1 Existing Industries and Monitoring Procedures Implemented

Today a total number of 27 industries is discharging their wastewater in the sewer networks for treatment in the Chunga WWTP. Of the 27 industries main sectors are breweries (6), drinks and beverage products (4), slaughter houses and/or meat processing (3), dairy products (2), tanneries /leather processing (2), paints (3) and others. This composition indicates a significant diversification of the industrial sector in the catchment area of the Chunga WWTP.

A listing of all 27 industries is provided as Annexes 7 and 8. This includes the specific production profile of each company, but also wastewater specific information.

Nowadays all these companies are already monitored by the LWSC monthly or bi-monthly by taking grab samples. The parameters temperature, pH, BOD and COD are analysed and recorded. In fact, the list of parameters is too limited and may not inform LWSC on the adequacy of the pre-treatment especially with respect to parameters that their plants are not able to address. Also, industry and/or sector specific approach is followed. Finally, the poor condition of the central laboratory located at the Manchinchi WWTP does not allow adequate monitoring procedures.

8.4.2 Quality Monitoring Program on Selected Industries

In the context of his scope of works in May/June 2015 the EIB FS Consultant has undertaken a Quality Monitoring Program on selected industries. Based on questionnaires submitted to all 27 industries identified before, 10 industries were selected. The final selection should reflect the presence of the main industrial sectors and the pollution potential of each individual company. The next Table 8-5 shows the selection of companies which has been included in the monitoring program.

Table 8-5: Industries included in the quality monitoring program

No.	Sector	Company/industry	Pre-treatment
1	Breweries	National Breweries Plc	- pH-neutralisation - screening and grit removal
2		Zambian Breweries Plc	- pH-neutralisation - anaerobic reactor / aeration tank - flow equilisation - screening and grit removal - gravity sedimentation
3	Tanneries	Keembe Tanneries Limited	- no information available
4	Bewerages/drinks	Californian Beverages Limited	- pH-neutralisation - biological treatment - sludge separation - stainers, filters
5		Heinrich Syndicate Limited	- pH-neutralisation - biological treatment - sedimentation tank
6	Dairy and milk processing	Parmalat	- production stream: chlorination
7	Slaughter houses	Real Meat Products	- air flotation system
8	Paint industries	Kansai Plascon Limited	- no information available
9	Other agriculture and food industries	Zamanita Oil Limited	- chemical precipitation - aeration ponds / settling ponds
10	Others	Trade Kings Limited	- pH-neutralisation - sedimentation tank

Source: COWI (2015a): Flow Measurement and Sampling Report

Pre-treatment: All industries included in the monitoring programme are equipped with different types of pre-treatment facilities. But, for all industries surveyed, not a single pre-treatment plant incorporates a unit operation for removal of soluble BOD. This means BOD removal for most of these plants is only through the physical separation of organic matter from the effluent through physical processes like sedimentation.

With view to all existing 27 industries, slightly over 70% of industries within the catchment areas have pre-treatment plants.

Parameters analysed: Since the industries are in distinct sectors, a differentiated analytical schedule was scheduled as follows:

- food and beverage industries: BOD, COD, suspended solids, fat, oil and grease, total N and chloride;
- tanneries: sulphide, chloride, pH, ammonia, total N, BOD, COD, chromium and cadmium; and
- paint production: cobalt, copper, zinc, cadmium, lead, nickel, organic solvents, chloride, sulphate and suspended solids.

8.4.3 Results of the Quality Monitoring Program on Selected Industries

For all industries sampled, pH, sulphates, ammonia nitrates and phosphates all conformed to the local administrative (Trade effluent) regulations. This also applies to the concentrations of heavy metals. But in this context it has to be mentioned that due to methodological problems the sample of Kembee Tanneries was not analysed.

For the remaining parameters, especially suspended solids and organic matter (COD), most industries breached the regulatory standards for discharge which is outlined to be 1,200 mg/l TSS and 1,800 mg/l COD. Selected results are summarised in the following Table 8-6. Accepting the fact that all industries partly massive exceed the discharge standard for the organic load (COD), in combination with concentrated TSS values it becomes clear that the breweries and the beverages/drinks producing sectors significantly contribute to high loads at the WWTP inlet.

Table 8-6: Selected results of the quality monitoring program. Orange marked cells indicate the exceeding of the imposed standard.

No.	Company/industry	pH	TSS	Nitrates	COD unfiltered	COD filtered	BOD unfiltered	BOD filtered	Faecal coliforms
			mg/l						CFU/100 ml
1	National Breweries Plc	8.49	25,795	16.82	48,600	6,560	1,900	500	600
2	Zambian Breweries Plc	6.3	15,568	8.88	55,600	24,500	2,200	474	800
3	Keembe Tanneries Limited	7.72	812	12.38	64,000	10,690	1,500	240	7,500
4	Californian Beverages Limited	7.01	926	6.96	18,200	4,350	800	300	8,000
5	Heinrich Syndicate Limited	5.45	2,945	11.76	19,800	6,980	2,200	204	9,500
6	Parmalat	7.28	690	7.58	78,100	10,140	1,700	220	7,500
7	Real Meat Products	7.06	613	13.18	12,800	8,800	3,300	340	9,000
8	Kansai Plascon Limited	6.07	5,420	25.02	28,800	7,600	1,100	280	8,000

No.	Company/industry	pH	TSS	Nitrates	COD unfiltered	COD filtered	BOD unfiltered	BOD filtered	Faecal coliforms
			mg/l						CFU/100 ml
9	Zamanita Oil Limited	6.99	1,017	<0.01	9,600	3,240	1,600	380	6,000
10	Trade Kings Limited	7.3	1,065	26.4	9,920	2,240	1,800	440	700

Source: COWI (2015a): Flow Measurement and Sampling Report

Sampling data: June 26, 2015; Laboratory: UNZA

Future perspectives

For responsive action adapting industries to future requirements reference is made to COWI 2016, Chapter 4.4 ‘Supporting Measures’.

9 FURTHER PROCEEDINGS

Given by the nature of the current ESIA study providing an overview on selected treatment options (Draft ESIA Report referring to Options 1-4C) and further investigating Option 5 in detail (Final Draft ESIA Report) in this chapter reference is made to issues which are to be addressed under the subsequent ESIA studies in accordance with the relevant Zambian ESIA standard. This is including the following issues:

- Requirement for additional specialized studies,
- Discussion and agreement of the effluent standard to be achieved by the proposed New Chunga and Ngwerere WWTPs and corresponding treatment process design, and
- ESIA requirements under the Zambian standard, here the number and type of ESIAs to be executed.

9.1 Requirement for Additional Studies

The following specialised studies are to performed in accordance with the Zambian ESIA standard or have been indicated as result of consultations with ZEMA. It should be noted that the listed studies hereafter is representing the current status, thus additional specialised studies might be requested.

- Sludge Management Plan

  During the next years with the increased implementation of wastewater treatment capacity significant volumes of sewage sludge will be generated and need to be reused or safely disposed. However, currently no regulative framework is in place; moreover ZEMA is considering sewage sludge as hazardous waste.

  In case of Chunga WWTP due to the high content of heavy metals is considering the sludge as hazardous waste. In the absence of a hazardous disposal facility in the country, ZEMA advised that the sludge storage facility / capacity needed to be one of the aspects to be addressed under the new ESIA study in accordance with the Zambian Standard.

  ZEMA further advised the investigation of conditions for land disposal (here agricultural reuse) as this might be associated with advanced treatment of the sludge in order to guarantee the imposed quality standards.

- Agricultural Areas and Corresponding Crop Structure

  Corresponding to the requirements of a Sludge Management Plan, potential agricultural areas need to be identified. Today, minor volumes of sludge from Chunga WWTP (!) are sold to small-scale farmers nearby. In future facing the significant volumes this practice is not appropriate anymore. As far as the sludge quality is suitable for agricultural reuse extensive areas are required. As an essential pre-requisite, areas are to be identified along with the current crop structure and given soil conditions (sloping, nutrient and heavy metal concentrations). This study then also forms the basis allowing the calculation of transport capacities and (temporary) storage facilities.

- Solid Waste Disposal Facilities

  Further to the statements made before related to the sewage sludge disposal, the future WWTP operation will also generate significant volumes of solid waste. This includes common municipal type solid waste, but also grit and screening material. Here temporary storage at the

WWTP area might be applicable, finally all these types of waste need to be safely disposed. Hereto, the final disposal capacity of the municipal landfill should be investigated.

- Groundwater Quality Investigation and Assessment

  Currently, no qualitative and quantitative groundwater baseline data around the WWTP sites are available. Existing data are from boreholes in the wider catchment and only collected sporadically.

  In case of Manchinchi and Garden pond sites – both sites are proposed to be sold – establishing a baseline of these contaminated sites would be useful for defence in future litigations, should they arise.

- Water Transfer among Catchments and Associated Water Rigths

  Accepting the scope of the current study providing an overview on selected future treatment options does not allow the in-depth identification and investigation of water loss and customary water rigths. Moreover, currently only a 'snap shot' investigation describing the dry weather flows of the concerned receiving waters is available. Both gaps should be subject of in-depth investigations allowing the detailed characterisation of the concerned catchments and associated water rigths.

- Capacity of the Receiving Waters

  As part of his scope of work, the EIB FS Consultant has performed capacity measurements (upstream – WWTP outlet – downstream) of the receiving waters, here the Chunga River and the tributary of the Ngwerere River. But these investigations were only made during the dry weather season.

  Accepting the higher volumes of generated effluent in future especially during the rainy season might be associated with the risk of floodings due to the unsufficient capacity of the receiving waters. Responding to this situation it is recommended to perform a one year measurement campaign investigating the flow regime, along with a river-morphological study. Resulting from these investigations the requirement of retention structures should be clarified.

  In case a potential flooding risk becomes evident corresponding mitigation measures are to be developed and implemented.

- Right of Way along the WWTP Transfer Pipeline

  All findings presented so far have been prepared without an in-depth investigation of the rigth of way.

9.2 Effluent Standards

Note: This chapter is compiling information and discussions already published in other documents. For the full follow up of the discussions between the EIB FS Consultant and ZEMA reference is made to the final FS report (COWI, 2015b; Chapter 2.2).

Rationale

During the early project phase the EIB FS Consultant had organised initial consultations with ZEMA seeking clarification on applicable effluent design criteria. Key objective of the consultation was the clarification of individual effluent parameter as outlined in the Environmental Management Regulations SI 112 of 2013 (hereafter called the' Zambian standard') and its applicability to the project. In this context the following effluent parameters have been discussed: BOD / COD (ratio), nitrogen (here total

nitrogen, ammonia, ammonium), phosphorus and the microbiological parameter Escherichia coli, faecal coli, total coliforms).

Arguing that the application and achievement of the effluent criteria in question is requiring a more sophisticated technological approach what would be connected with an higher area demand and/or higher costs, the EIB FS consultant has been proposed the application of the relevant EU Standard (Urban Wastewater Treatment Directive, 91/271/EEC) or in case of the microbiological effluent parameters faecal and total coliforms instead of the parameter Escherichia coli.

A breakdown of the consultations amongst the EIB FS Consultant and ZEMA is summarised in the next Table 9-1.

Table 9-1: Summary of effluent standards

Effluent parameters	Unit	Zambian standard	EU standard	Critical issues
BOD_5	mg/l	50	25	
COD	mg/l	90	125	
Escherichia coliforms	cells/100ml	10		Achieving the Zambian standard would require a technological upgrade that migth be associated with a higher area demand and/or higher costs.
Faecal coliforms		5000		
Total coliforms		25000		
Total nitrogen	mg/l		10*	
Total ammonia (NH_3)	mg/l	10		see comment for microbiological parame-ters
Total ammonium (NH_4)	mg/l	10		
Total phosphorus	mg/l	6	1*	

* WWTPs > 100,000 PE and for discharges in sensitive areas
Source: COWI (2015b): WWTP Options & Sludge Management Plan Report - Final; Chapter 2.2

As preliminary outcome, the consultations have indicated that, apparently, ZEMA might be open for a pragmatic approach towards deviations to the effluent criteria, if such can be justified.

In response to this situation the following parameters have been waived and adopted as follows:

- E-coli criteria > by Faecal / total coliforms;
- In case of stabilisation ponds: Ammonia/Ammonium criteria; and
- COD/BOD ratio.

Position of ZEMA

During a consultation meeting of all important stakeholders (LWSC, KfW, EIB and ZEMA) held June 29, 2016 in the ZEMA premises the position of ZEMA was stated as follows:

The FS study undertaken by the EIB FS Consultant established that the technology to be used in the constructed WWTP would **not** attain the quality of the treated effluent as provided for by the Environmental Management Regulations SI 112 of 2013 as they were very strict. This is despite the proposed technology attaining EU treated effluent standards. Overall, it was noted that the Zambian standards for the treated effluent were very stringent and thus proposed treatment technology would not achieve the treated effluent of the standards required by the Zambian Laws.

Therefore, this presented a very big challenge to the donors because when the WWTP would be commissioned, it would already be in breach of the Laws in Zambia.

To clarify the situation, LWSC had formally written to ZEMA to request for the review of the standards but ZEMA indicated that these could only be considered in the consequent review of the regulations. Nonetheless, because of the timelines in the implementation of the projects, an advice was being sought from ZEMA on how best the issue of the quality standards of the treated effluents could be handled.

ZEMA informed the meeting that the standards being referred to where statutory limits contained in Statutory Instrument (SI), as such there were laid down procedures to be followed for the review and/ or amendment of Statutory Instruments. ZEMA cannot on its own review and/ or amend SI without consultations with the Government through the Ministry of Justice. The Ministry of Justice are the custodian of the laws and in effect determine the speed at which any such reviews and/ or amendments to SIs are effected. Therefore, ZEMA would have to seek authority from the Ministry of Justice to go ahead with the review and/ or amendments to the Environmental Management Regulations SI 112 of 2013.

Future suggestions

- In general, LWSC was of the opinion that it would not only be very expensive for water utility companies in Zambia to invest in technologies that would meet the ZEMA effluent standards but it was also a waste of resources to discharge clean water into dirty water.
- This statement can be fully supported as water quality monitorings prepared in June 2015 have indicated a massive organic pollution (BOD, COD) in the receiving waters, especially in the Chunga River. Reference is made to Chapter 6.1.3, Table 6-4. Accepting this situation ‘advanced’ wastewater treatment efforts as imposed by the Zambian Standard are not justified.
- Effluent discharged into the receiving waters is at risk of being “re-contaminated”. In case of microbiological contamination being present in the receiving waters technological efforts for the chlorination process (equipment, energy, and chemical inputs) are without sustainable effect.
- In case ZEMA cannot waive the current ‘advanced’ effluent criteria, it might besome necessary to redesign the WWTPs towards the adaptation of more advanced treatment systems and/or more sophisticated technologies. Hereto, the EIB FS Consultant has undertaken a comprehensive investigation. Currently, LWSC staff is familiar operating conventional trickling filter systems. The orientation to other treatment technologies may result in increased WWTP operation efforts which necessitate the deployment of qualified, skilled staff.

- In the same context, advanced treatment systems might be associated with higher energy consumption and/or the higher generation of sewage sludge. In this case advanced effluent quality goes to the expense of increased environmental costs.
- Facing significant investments in the Zambian water and sanitation sector requires the ultimate clarification of the applicable effluent criteria. This issue has overwhelming importance for international donors, investors but also the future WWTP operators.

9.3 ESIA Requirements according to Zambian Standard

In terms of the type and content of the ESIA studies to be executed under the Zambian ESIA standard, consultations were held with ZEMA dated June 29, 2016 attended by representatives of all important stakeholders (LWSC, KfW, EIB and the EIA Consultant). With letter dated August 08, 2016 (made available to the EIA Consultant August 23, 2016) ZEMA has requested separate ESIA studies (including Resettlement Action Plans) to the following sub-project and/or locations:

- Rehabilitation and upgrading of Chunga WWTP,
- Upgrade of Ngwerere waste stabilization ponds to a biological trickling filter WWTP,
- Sewer network (here wastewater transfer pilpeline) from Manchinchi WWTP (Garden ponds) to Ngwerere site (along pipeline CSU-7),
- Decommissioning of Manchinchi WWTP and associated Garden ponds,
- Upgrade of sewage pumping stations and main collectors, and
- Expansion of sewer network (by 520 km).

Hereby repective ESIA steps have to follow the Zambian ESIA procedure as outlined in Chapter 2.5 ‘EIA Process in Zambia’.

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11 ANNEXES

Annex 1: Legislative and Institutional Framework – National Policies

National Policy on Environment

The National Policy on Environment (NPE) is the principal policy that coordinates environmental management in Zambia. The NPE is designed to create a comprehensive framework for effective natural resource utilization and environmental conservation which will be sensitive to the demands of sustainable development. The specific objectives of the NPE are to:

- promote the sound protection and management of Zambia's environment and natural resources in their entirety, balancing the needs for social and economic development and environmental integrity to the maximum extent possible, while keeping adverse activities to the minimum;
- manage the environment by linking together the activities, interests and perspectives of all groups, including the people, nongovernmental organizations (NGOs) and government at both the central and decentralized local levels;
- accelerate environmentally and economically sustainable growth in order to improve the health, sustainable livelihoods, income and living conditions of the poor majority with greater equity and self-reliance;
- ensure broadly-based environmental awareness and commitment to enforce environmental laws and to the promotion of environmental accountability;
- build individual and institutional capacity to sustain the environment;
- regulate and enforce environmental laws; and
- promote the development of sustainable industrial and commercial processes having full regard for environmental integrity.

The NPE reinforces the strategy to capacitate MLGH Department of Housing and Infrastructure Development (DHID) and local authorities with adequate resources to rehabilitate and extend sewerage systems and other forms of sanitation and develop and manage solid waste systems.

National Water Policy

The National Water Policy is the overarching policy framework for the water and sanitation sector in Zambia. The Policy was developed and adopted by the GRZ in 1994, and subsequently updated in 2010. The National Water Policy envisions “to optimally harness water resources for the efficient and sustainable utilization of this natural resource to enhance economic productivity and reduce poverty”.

In order to achieve the national goal of increasing accessibility to reliable safe water by all sectors of the economy the policy addresses two broad categories of water resources management and development. The major outcome of the policy is to improve the management of water resources, institutional coordination and defined roles and responsibilities. The policy encourages the use of water

resources in an efficient and equitable manner consistent with the social, economic and environmental needs of present and future generations.

National Conservation Strategy

The National Conservation Strategy (NCS) formulated in 1985 has been the main policy document on the Environment and Natural Resources in Zambia. The NCS was prepared by the Government to manage natural resources and the environment in the context of a centrally planned and controlled economy. The Strategy's main goal is to: "…satisfy the basic needs of all the people of Zambia, both present and the future generations, through the wise management of natural resources".

The strategy establishes policies and devises plans and to fully integrate conservation into Zambia's social and economic development. It also aims to analyse trends and current issues to better anticipate problems and needs.

National Environmental Action Plan

The focus of the National Environmental Action Plan (NEAP) of 1994 is to identify environmental problems and issues, analyse their causes, and recommend necessary interventions. The NEAP was prepared as a comprehensive plan to contain the ever increasing environmental degradation in Zambia. The preparation of NEAP was as a result of Government's desire to update the NCS for the following reasons:

- the economy was undergoing a period of liberalization;
- the main NCS recommendations had been implemented;
- the technical information in the NCS needed updating; and
- there was a requirement by World Bank for a NEAP as a prerequisite for International Development Association (IDA) loan funding.

The NEAP is founded on three fundamental principles:

- the right of citizens to a clean and healthy environment;
- local community and private sector participation in natural resources management; and
- obligatory EIA of major development projects in all sectors.

The overall objective of the NEAP is to integrate environmental concerns into Zambia's social and economic development planning process.

National Gender Policy

From time to time, the GRZ has been making attempts to mainstream gender in the different sectors of the country. In the 1980s, government adopted the Women in Development (WID) approach as a framework to incorporate gender issues into its development activities. For example, there was a WID desk at the then National Commission for Development Planning. In 1996, this approach was changed to the Gender in Development Division (GIDD). In the year 2000, the government launched the National Gender Policy which serves as a gender mainstreaming institutional framework for government ministries. In the year 2006, the government established the Ministry of Women's Affairs which was later changed to the Ministry of Gender and Development to oversee the gender mainstreaming activities in the country.

In order to resolve the problems pertaining to the provision of safe and clean water, and good sanitation which affects women more than men, government has put the following measures in the National Gender Policy: The Government will:

- promote and encourage the involvement of women in the decision making processes in the provision of safe and clean water and improvement of sanitation facilities;
- encourage partnerships between women and men in the provision of water and sanitation;
- ensure use of gender friendly technology in water supply and sanitation to all members of the community especially persons with disabilities;
- devise a mechanism to ensure that water and sanitation facilities companies provide affordable, clean, and safe water through a regulator; and
- establish investment mechanisms to ensure that water reticulation systems take into account issues of hygiene to prevent water borne diseases.

The above measures are the guidelines in the water and sanitation sector. It is expected that all government projects on water, sanitation and drainage will adhere to the requirements of the National Gender Policy of 2000 particularly in the incorporation of gender issues.

National Adaptation Programme of Action on Climate Change

The Ministry of Tourism, Environment and Natural Resources developed National Adaptation Programme of Action (NAPA) on Climate Change in the year 2007. Herewith Zambia recognizes that it has limited resources to effectively respond to the threats posed by climate change. It has therefore taken appropriate steps by responding to the United Nations Framework Convention on Climate Change (UNFCCC) initiatives, to which it's a party, and devised strategies against climate change through this National Adaptation Programme of Action (NAPA) and other programmes.

The NAPA will complement the efforts of the government through the following:

- contributing to the security of the vulnerable Zambians;

- ensuring that the livelihoods of the most vulnerable households are secured against the adverse effects of climate change and their basic needs assured;
- vulnerable groups are protected from the worst impacts of risks and shocks as a result of climate change; and
- creating public awareness of the adverse effects of climate change.

Sixth National Development Plan

The Ministry of Finance and National Planning (MFNP) developed the Sixth National Development Plan (SNDP) which contains a chapter on water and sanitation. According to the SNDP, all sectors such as agriculture, mining, industry, housing and energy require access to adequate water and sanitation services for their development. The water and sanitation sector vision is “a Zambia where all users have access to water and sanitation and utilise them in an efficient and sustainable manner for wealth creation and improved livelihood by 2030”. The sector goal is “to achieve 75% accessibility to reliable safe water and 60% adequate sanitation by 2015 in order to enhance economic growth and improve the quality of life”. In order to achieve the SNDP objective of promoting sustainable water resources development and sanitation, the strategic focus of the sector will be to provide water and sanitation infrastructure and develop skills to ensure effective water resource management and the efficient provision of reliable and safe water and sanitation services.

National Biological Diversity Strategy and Action Plan

In May 1993 Zambia ratified the Convention on Biological Diversity and as part of the commitment to fulfil its objectives Zambia developed the National Biological Diversity Strategy and Action Plan (NBSAP), which was finalized in 1998.

National Forestry Policy

The mission statement of the forestry sector is to ensure sustainable flow of wood and non-wood forest products and services while at the same time ensuring protection and maintenance of biodiversity for the benefit of the present and future generations.

National Decentralisation Policy

The National Decentralization Policy (developed in 2002, launched in 2004) aimed at decentralizing government responsibilities and functions to lower levels of government through ‘devolution’. It reaffirms the local authorities as the institutions responsible for water supply and sanitation.

National HIV and AIDS Strategic Framework

The National HIV and AIDS Strategic Framework (NASF) 2006-2010 was built on the process of joint annual reviews and a broad consultative process with the cooperating partners.

Annex 2: Legislative and Institutional Framework – National Environmental Laws and Regulations

Environmental Management Act

The Environmental Management Act, 2011:

- continues the existence of the ECZ and re-name it as the ZEMA;
- provides for integrated environmental management and the protection and conservation of the environment and the sustainable management and use of natural resources;
- provides for the preparation of the State of the Environment Report, environmental management strategies and other plans for environmental management and sustainable development;
- provides for the conduct of strategic environmental assessments of proposed policies, plans and programmes likely to have an impact on environmental management;
- provides for the prevention and control of pollution and environmental degradation; provides for public participation in environmental decision making and access to environmental information;
- establishes the Environment Fund;
- provides for environmental audit and monitoring;
- facilitates the implementation of international environmental agreements and conventions to which Zambia is a party;
- repeals and replaces the Environmental Protection and Pollution Control Act, 1990; and
- provides for matters connected with, or incidental to, the foregoing.

Sections 29 and 30 of Part II of the Act set out the requirements for EIAs and the regulations relating to environmental assessments respectively. A person shall not undertake any project that may have an effect on the environment without the written approval of the ZEMA, and except in accordance with any conditions imposed in that approval. The ZEMA shall not grant an approval in respect of a project if it considers that the implementation of the project would bring about adverse effects or that the mitigation measures may be inadequate to satisfactorily mitigate the adverse effects of the proposed project.

Part IV of the Act makes provision for control of pollution (land, air and water, ozone depletion), the control of general and hazardous waste and the conduct of EIA. The ZEMA has the powers of arrest and prosecution under the Act. Regulations promulgated in terms of the Act include the following:

- Water Pollution and Control (Effluent and Waste Water) Regulations (1993), which provide for the licensing of effluent discharges;
- Air Pollution Control (Licensing and Emissions Standards) Regulations (1996), which require point-source polluters to be licensed;
- General Waste Management Regulations (1993), which require the transportation and disposal of waste, as well as the waste disposal site to be licensed;
- Hazardous Waste Management Regulations (2001), which provide for the storage, transportation, handling, treatment, and illegal trafficking of such waste;

- Pesticides and Toxic Substances Regulations, which stipulate the registration, labelling and packaging, general handling, use and safety, and storage and disposal of pesticides and toxic substances;
- Ozone Depleting Substances Regulations (2000), which detail control measures and permit requirements; and
- EIA Regulations (Statutory Instrument No. 28, 1997), which list activities requiring assessment and responsibilities pertaining to them (see Section 2.3.3).

The Act states that a developer shall not implement a project for which a project brief or an environmental impact statement is required, unless the project brief or an EIA has been concluded in accordance with the Act and the ZEMA has issued a decision letter. The Act also provides for undertaking of an environmental audit of the project.

The Act prohibits any person from polluting the water by discharging effluent or wastewater. It states that no person may discharge or apply any poisonous, toxic, obnoxious or obstructing matter, radiation or other pollutant or permit any person to dump or discharge such matter or pollutant into the aquatic environment in contravention of water pollution control standards established or prescribed by the Agency. Effluent from backwashing of filters and sludge from clarifiers at the LWSC water treatment plant will have to conform to the Act.

The Act prohibits any person from polluting the air. It states that no person may emit any pollutants which cause air pollution in contravention of emission standards established or prescribed by the Agency. The Act also states that the Inspectorate may request an owner or operator of an operation of which the Inspectorate has reasonable grounds to believe results in the emission into the ambient air of any air contaminant, to submit all information relating to those emissions as the Inspectorate may require. Indiscriminate disposal of waste is prohibited by the Act. It states that no person shall discharge waste so as to cause pollution in the environment. It further states that no person shall transport waste to any site other than in accordance with a license and to a disposal site established in accordance with a license. It also states that a person shall not operate a waste disposal site or plant or generate or store hazardous waste without a permit or license. Solid waste will be generated in the project and will have to be handled and disposed of in accordance with this Act.

The Act prohibits noise emission in excess of established standards unless the ZEMA inspectorate grants permission. The Act states that no person shall emit noise in excess of the noise emission standards. The Inspectorate may grant a permit in writing allowing excessive emission of noise under such terms and conditions as it may determine. Noise will result from construction activities and operation of the drainage water supply systems. Therefore, the project activities have to be done in conformity with the Act.

Statutory Instrument No. 28

Statutory Instrument (SI) No.28 under the Environmental Protection and Pollution Control (Environmental Impact Assessment) Regulations, 1997 amongst other requirements sets down the detailed procedures for the preparation of ESIAs, consultations, approvals and monitoring.

Water Supply and Sanitation Act

The Water Supply and Sanitation Act, 1997, consolidates legislative actions under The Water Act, 1948; the National Water Policy, 1994; and the Water Pollution Control (Effluent and Waste Water Regulations), 1993. The responsible agency for these environmental policies is the Department of Water Affairs – Ministry of Energy and Water Development (MEWD). The purpose of these policies is to provide for ownership, control and use of water. The aim is to promote sustainable water resources development with a view to facilitating an equitable provision and adequate and quality water for all users and to ensure security of supply under varying conditions.

The Act provides for the establishment of the National Water Supply and Sanitation Council (NWASCO) which acts as a regulator in the provision of water supply and sanitation services. It mandates NWASCO to regulate the sector in a manner leading to improved delivery, efficiency and sustainability. The Act requires NWASCO to disseminate information to the public on matters relating to water supply and sanitation services.

The Act regulates water supply and sewerage utilities for the purpose of protecting consumers from unjustified tariffs. As specified under the Act, there are four options for local authorities to provide services. The local authority may:

- provide services through a section within the Lusaka City Council (LCC);
- establish a commercial utility as a company licensed and regulated by NAWASCO;
- entrust the management to a private operator while the assets are management by the local authorities or holding company; or
- sell off up to 49% of its equity to a private company and then together form a commercial entity.

Any service provider supplying water to more than 500 persons has to be regulated by NWASCO. If the service provider operates on a commercial basis, NWASCO is concerned with the service level and water quality. A utility or service provider may construct any facility within or outside its area for the provision of water supply and sanitation services.

Water services in Lusaka should therefore be provided by the LWSC. The company also provides a licence to water trusts for provision of water services in peri-urban areas. The utility is also regulated by NWASCO in terms of performance and tariffs among others.

The Millennium Challenge Act

The Millennium Challenge Act No. 6 of enacted March 21, 2013 launched the implementation of the Millennium Challenge Compact Programme (Section 1.1). As previously explained the programme is as a result of an agreement that was signed by the United States of America acting through the MCC, and the GRZ. The Government has since tasked The MCA-Zambia to oversee, manage and implement the MCC programme in Zambia.

The major aims of the Act are to:

- Expand access to and improve reliability of water supply, sanitation and drainage services in select urban and peri-urban areas of the City of Lusaka in order to reduce the incidence of waterborne and water related diseases.
- Generate time savings for households and businesses and reduce non-revenue water in the water supply network by improving water supply and sanitation and drainage services and
- Provide for matters connected to, incidental to, the foregoing.

Water Resources Management Act

The Water Resources Management Act, 2011, establishes the Water Resources Management Authority and defines its functions and powers. It also repeals and replaces the Water Act, 1949.

The ownership of all water is vested in the President. The use, diversion and apportionment of all water shall be made in terms of this Act. Any person may make an application to the Secretary of the Water Resources Management Authority for permission to impound and store or divert water from a public stream for primary, secondary or tertiary use, and the Water Board may grant such application on such terms and conditions as it may think fit provided that any such grant is made with reasonable regard to the primary use of water and any existing rights lawfully granted for any other purpose.

Whenever a local authority desires to appropriate any public water for primary or tertiary purposes necessary to the community under its jurisdiction, such local authority shall, in the absence of any special law authorizing such appropriation, make application to the Secretary, setting out such particulars of the proposed appropriation as may be required by the Secretary or as may be prescribed. If the public water applied for is being beneficially used for secondary or tertiary purposes by any other person by virtue of any right granted under this Act or any other written law or by agreement with the Government, the use required by the local authority may be authorized by the Water Board to the extent it may deem fit on payment of compensation to such other person after full inquiry as hereinafter provided.

Every water right which has been granted for a period of time shall be renewable in accordance with the provisions of the Act. In case the owner of any right registered fails to make full beneficial use of

the same for a consecutive period of three years or fails to comply with any condition imposed under the Act requiring any works to be constructed and maintained, he may risk forfeiture of the water rights.

Under this Act, any person who wilfully or through negligence pollutes or fouls any public water so as to render it harmful to man, beast, fish or vegetation shall be guilty of an offence and liable to a fine or imprisonment. It also empowers the Water Officers to call upon the person responsible therefore to take adequate measures to prevent such fouling or pollution within a specified period.

Abstraction of water from the Kafue River will have to be done according to the water right. LWSC also has to renew its water right periodically. The water supply system has the potential to pollute water bodies and as such the operation of the system should abide by this Act.

Lands and Deeds Act

The Lands and Deeds (Registry) Act provides for: the registration of documents; to provide for the issue of Provisional Certificates of Title and Certificates of Title; the transfer and transmission of registered land; and matters incidental. It is widely cross-referenced in other legislation, relevantly in connection with land acquisition and easements.

Its provisions do not cover individual plot certificates of title and occupancy in local council Statutory Housing and Improvement areas, although the areas themselves are gazetted and registered.

Lands Acquisition Act

The 1970 Lands Acquisition Act replaced the Public Lands Acquisition Act 1958 (CAP 87). It was amended by SI 110 of 1992 and Act 13 of 1994.

Sections 3, 5 and 6 empower the President in the interests of the Republic to acquire any property of any description and lay down the procedures whereby the Minister of Lands (formerly Lands and Natural Resources) may do so. The Minister (Section 7) gives public notice of intention to acquire and take possession of property, normally within two months but less in certified urgent cases. Those with an interest in property may notify the Minister. Nobody may be forced to yield a portion only of a house or building, or a portion of land that leaves an unusable relict, but may elect for the expropriation of the whole (Sections 8, 9).

Part III of the Act lays down the principles of compensation, including full market value, and provides for basic principles of compensation and Part VI establishes a statutory Compensation Board with Committees to advise the Minister, who is however not bound by its recommendations. It also provides for appeals against awards. Section 10 provides that where the property acquired is land the President

may, with the consent of the person entitled to compensation, make, in lieu of or in addition to any compensation payable, a grant of other land not exceeding in value the value of the land acquired, on similar terms and conditions. Disputes may be referred by either side to the High Court but do not affect the right to enter into possession of the property.

Part IV prescribes that unutilized land, including urban land occupied by squatters and trespassers, and badly-managed rural land may be acquired without compensation (Sections 15 (1) and (4) (b)).

Transfer of title to the President is done by the owner, failing which the Minister may apply for entry in the Land Registry. Penalties are prescribed for the offence of obstructing or hindering land acquisition (Sections 17 to 20).

The Act lays down strict principles of compensation, evidently so as to avoid overcompensation in the interests of prudent management of public resources. It recognizes no compensation rights other than full and documented property rights. Any other occupants of the land in question would be liable to summary eviction without assistance of any kind. Government officials, and indeed other Zambian legislation such as the Water and Sanitation Act see the Land Acquisition Act as an act of last resort, when all other attempts have failed.

Land Conversions of Titles Act

The Land Conversions Title Act provides for the alienation, transfer and change of land. The Act also provides for compulsory acquisition of land by the President whenever he is of the opinion that it is desirable or expedient to do so in the interest of the Republic.

The Town and Country Planning Act

The Town and Country Planning Act (CAP 283) provides for: the appointment of planning authorities; the establishment of a Town and Country Planning Tribunal; the preparation, approval and revocation of development plans; the control of development and subdivision of land; the assessment and payment of compensation in respect of planning decisions; the preparation, approval and revocation or modification of regional plans; and incidental matters.

Part III deals with development plans. Section 16 (2) provides for development plan mapping to illustrate the proposals, and in particular to designate as land subject to compulsory acquisition by the President or by a local or township authority:

(a) land reserved for government or local authority purposes;

(b) areas designated for comprehensive development, and adjacent areas; and

(c) other land in order to secure its vocation for plan purposes.

The same section also provides for designation for compulsory acquisition areas that are not properly laid out that need future treatment, or are obsolete for development needs. It may require the relocation of population or industry or the replacement of open space or any other purpose needed for comprehensive development and development or redevelopment as a whole.

Part VI deals with compensation for refusal of planning permission, including subdivision, if it can be shown that there was material prejudice resulting; and with the circumstances and details of what may and may not be allowable.

Part VII on Land Acquisition (Sections 40 to 44) applies to the provisions of the Land Acquisition Act (Chapter 189), making such adjustments as are necessary to permit the acquisition of land by a local authority.

Occupational Health and Safety Act

The Occupational Health and Safety Act, 2010 establishes the Occupational Health and Safety Institute as a body corporate with perpetual succession and defines its composition, powers, and functions. The Act provides for the establishment of health and safety committees at workplaces and aims to provide for the health, safety, and welfare of persons at work and persons who may face risks to health or safety arising from said work, and to establish the duties of manufacturers, importers, and suppliers of items for use at work.

Part II of the Act sets down the Institute's functions, the following of which are particularly relevant to the LWSSD Project:

- develop and implement programmes to provide incentives for employers to implement measures to eliminate or reduce risks to health or safety or to improve occupational hygiene, occupational health and safety;
- investigate and detect occupational diseases and injuries at workplaces; and
- set and maintain standards for the protection of the health and safety of employees at workplaces.

Part III prescribes the establishment and composition, of health and safety committees for employers of ten or more employees and describes the committees' functions, which include but are not limited to:

- promotion of cooperation between the employer and the employees in achieving and maintaining healthy and safe working conditions;
- investigation and resolution of any matter that may be a risk to the health and safety of employees at a workplace; and
- formulation, review, and dissemination to the employees of the standards, rules, and procedures relating to health and safety to be carried out at the workplace.

Part IV of the Act contains guidelines for the determination of what is “reasonably practicable” at a workplace, as well as the duties of:

- employers to employees and to persons other than employees;
- employees at workplaces;
- persons in control of workplaces or plants;
- designers, manufacturers, suppliers, and importers; and
- architects and engineers.

Additionally, this Part protects employees from dismissal or victimization under several conditions in which he/she may express concern, exercise power, or divulge information regarding health and safety matters.

The remainder of the Act describes the enforcement provisions of key entities under the Act, describes the services incumbent upon the Occupational Health and Safety Institute, and includes general provisions (exemptions, penalties, offences, regulations, etc.) and schedules of institutional proceedings and financial activities.

The Act states that an engineer shall carry out his duties in such a manner as to ensure the occupational health and safety of persons at, or near, a workplace. Construction and operation of the project will have to be carried out in accordance with the provisions of this Act.

Other relevant regulations

Further relevant regulations are:

- Public Health Act, 1995 (CAP 295)
- National Health Services Act (CAP 315)
- Local Government Act (CAP 281)
- Zambia Wildlife Act, 1998
- Road Traffic Act, 2002
- Public Roads Act, 2002 (CAP 12)
- Registration and Development of Villages Act (CAP 289)
- National Heritage and Conservation Act, 1989 (CAP 173)
- Forestry Act
- Petroleum Act (CAP 435)
- Explosives ACT (CAP 115)
- Employment of Young Persons and Children Act (CAP 274)
- Anti-Human Trafficking Act, 2008
- Energy Regulation Act (CAP 436)

Annex 3: Legislative and Institutional Framework – Institutional Framework for LWWP and ESIA

Ministry of Mines, Energy and Water Development

The MEWD is responsible for initiating overall national water management policies and for setting national standards and priorities for water development and management.

National Water and Sanitation Council

The NWASCO is a statutory body established by the Water Supply and Sanitation Act No. 28 of 1997. According to the Act in Clause 4, NWASCO is mandated to regulate the provision of water supply and sanitation services. The NWASCO reports through the MEWD, this is in order to keep the regulatory function separate from the water and sanitation implementation function housed under the MLGH. The NWASCO has responsibilities for:

- developing policies regarding water and sanitation;
- setting standards and guidelines regarding water and sanitation;
- licensing water and sanitation utilities and monitoring their performance; and
- taking any necessary actions to ensure efficient and sustainable provision of water and sanitation services.

Zambia Environmental Management Authority

The ZEMA is a statutory body created under the Environmental Protection and Pollution Control Act of 1990, CAP 204. ZEMA was established in 1992 and is mandated to protect the environment and control pollution so as to provide for the health and welfare of persons, and the environment.

Part VI (49) of the act assigns to the ZEMA certain roles and responsibilities, amongst which are the following:

- formulate and provide standards on the classification and analysis of wastes and formulate and advise on standard disposal methods and means;
- publicize the correct means of storage, collection and disposal of any class of waste; and
- maintain statistical data on the nature, quantity and volume of waste generated and on sites where waste disposal is taking place or has taken place.

Lusaka Water and Sewerage Company Ltd.

LWSC was formed in 1988 under the Companies Act after the Water and Sewerage Department was detached from Lusaka City Council (LCC). It was not until 1990, however, that it commenced operations. Provincial utility status was granted in February 2008 as a Private Limited Liability Company,

with the councils of Lusaka (60%), Kafue (20%), Chongwe (10%) and Luangwa (10%) acting as the shareholders.

The Mission Statement of LWSC is “to provide quality water and sanitation services to customers in Lusaka Province at commercially and environmentally sustainable levels”. Their vision is “to be a world class water and sanitation service provider”.

LWSC operates using a non-executive Board of Directors which is appointed by the shareholders.

The LWSC owns and operates water supply and sewerage assets in Lusaka city proper and outlying communities. In addition to the usual planning, engineering, construction, plant operations and maintenance functions, the LWSC also maintains a geographic information system (GIS), mapping capability, computer networks, instrumentation and control (I&C), and administrative functions for governance, management, human resources, service rates, collections, disbursements and finance.

Lusaka City Council

The LCC is the governing local authority for the City of Lusaka, deriving its authority from several Zambian laws, but most immediately, Section 61 of the Local Government Act, which lists 63 functions of local authorities. The LCC responsibilities include, but are not limited to:

- provision and maintenance of supplies of clean water and the establishment of water works and water mains;
- construction and maintenance of sanitary lines;
- establishment and maintenance of sanitation and drainage systems to facilitate the removal of refuse and effluent;
- prohibit and control the use of land and erection of buildings in the interest of public health, safely and orderly development of the Council area; and
- approval to formalize unplanned settlements.

The Council comprises 33 wards, which are smaller geographic divisions within the City’s seven constituencies. From each constituency, one person is elected a member of parliament by popular vote and serves in the National Assembly. From each ward, one councillor is elected to serve on the LCC. The term of office for each position is five years. Current council members can be found at www.lcc.gov/zm.

The LCC contains eight departments, each headed by a director:

- Human Resource and Administration;
- City Planning;
- Valuation and Real Estate;
- Finance;
- Housing and Social Services;

- Public Health;
- Engineering Services, and;
- Legal Services.

The LCC departments most relevant to the sanitation infrastructure context in the peri-urban and urban settlement areas are the City Planning Department, the Department of Housing and Social Services and the Engineering Services. Each department contains a peri-urban section; however, work sharing between the two sections is unclear.

Ward Development Committees

Both urban and peri-urban areas of Lusaka are organized under Ward Development Commitees (WDCs). The WDCs are community structures created by the local authority to assist in providing oversight of these areas. The main responsibility of the WDC is to oversee development projects in their respective areas. Some of the specific responsibilities include:

- community mobilization/training and sensitization;
- needs identification;
- project proposal initiation;
- conflict resolution and management;
- advocacy;
- supervision/coordination of development projects; and
- project implementation and monitoring.

In their day-to-day activities, they work in collaboration with the representative of the Local authority based in their area (Community Development Assistant).

The WDCs are further sub-divided into Zone Development Committees. Issues such as health, education, water and sanitation, solid waste disposal, and other important issues make up their daily agenda. The work of these committees is voluntary often undertaking their activities in collaboration with various Community Based organizations (CBOs). The WDCs need to be consulted and engaged during the process of introducing any development program.

The WDCs are heavily involved in water and sanitation services as they own, operate, and maintain the community water supply schemes on behalf of the community. Most of these community managed schemes are in the form of Water Trusts where the WDC has employed a management team to run the scheme. Some members of the WDC sit on the Board of the Water Trust. Taps/kiosks are managed by vendors (the majority of whom are women) who sign a contract of rules and regulations on conduct, timetable of water service, pricing etc.

Although, initially, the Water Trusts were just dealing with water services, in recent years some have also taken on managing public toilets, implementing sanitation initiatives such as Ecological Sanitation (Eco-san) latrines and they have enhanced their traditional role of undertaking health and hygiene promotion.

Project relevant WDCs of Manchinchi, Chunga and Sylvia Masebo Compoud (Ngwerere ponds) are expected to be consulted on a regular basis. Hereby, established contacts between LWSC and the WDS are preferred.

Community-Based Organizations

The CBOs are groups within particular communities such as health associations and women's associations that are actively involved in sanitation and hygiene promotions mostly in rural areas and peri-urban areas. They normally encourage constructing pit latrines, hand washing practices, digging rubbish pits and handling food.

A few of the CBOs are:

- Neighbourhood Health Committee;
- Zambia National Marketeers Association (ZANAMA Branch);
- Waste Management Community Enterprise;
- HIV/AIDS Peer Educators;
- Community Health Workers;
- Home Based Care;
- Churches; etc.

One of the most active CBOs is the NHC. The NHCs were created under the Ministry of Health and get support from the local health clinic. They may be an important asset to assist in health and hygiene training related to water supply, as well as distribution of information, education and communication (IEC) materials in the communities. The members of the NHC undergo quite extensive training through the Ministry and one of their primary roles is to work in markets, schools, individual homes, and other locations to teach positive hygiene practices. With the recent cholera alert throughout Lusaka, the NHC has been a key resource in distributing information materials to address this issue in the communities they serve. In addition, the NHC conducts community drama/plays and uses the community radio for public announcements to further expand their message.

Non-Government Organizations and Cooperating Partners

Most of the NGOs have a bias towards the water sector, particularly the rural water sector. The NGOs operating in Lusaka have a strong expertise in building partnerships in communities and implementing

water sector projects in peri-urban areas. Some of key NGOs are listed below together with a brief description of their main activities.

- Zambia NGO WASH Forum: The Zambia NGO WASH Forum is a network of NGOs, Community Based Organisations and Civil Society Organisations working to improve water and sanitation.
- Water Aid: Supports local governments and builds their capacity to improve access to essential water and sanitation facilities and also work with communities to raise awareness of the importance of hygiene and sanitation
- Care International: Care International's work in Zambia is divided into different 'projects', each focusing on either one or multiple aspects of poverty including water, sanitation and environmental health
- SNV: SNV started operations in Zambia in 1965. In alignment with Zambia's Vision 2030 and its Sixth National Development Plan, SNV provides services in three sectors: agriculture, water sanitation, and hygiene and renewable energy.
- World Vision: Among other developmental activities, World Vision Zambia works in impoverished, mostly rural areas to provide potable water, improved sanitation, and hygiene education.
- Zambia Water Partnership: In 2004, with help from the Zambia Water Partnership, the Zambian Government began developing an Integrated Water Resources and Water Efficiency Plan for sustainable management of the country's water resources. This was part of the PAWD (Partnership for African Water Development) Project, carried out with support from the Canadian International Development Agency and the Global Water Partnership aiming to prepare Integrated Water Resources and Water plans

Cooperating partners (CPs) play a big supporting role in the water, sanitation, drainage and solid waste management sectors. Cooperating Partners include the United States Agency for International Development, the Government of the United Kingdom's Department for International Development, the Embassy of Japan, UNICEF (on behalf of the United Nations), the African Development Bank, and Irish AID, the Netherlands who contribute through UNICEF.

Annex 4: Protocols of community meetings

Subject: Community Meeting Manchinchi WWTP & Garden Ponds

Location: Manchinchi WWTP
Date: 10 September 2015

Time: 14.30 – 17.00 hrs

40 persons (20 women and 20 men) attending from surrounding communities Garden, Luangwa and Chilulu *(refer to participant list)*

Agenda & information gathered

Activity	Responsible	Content
1. Registration of Participants	CES	Refer to participant list
2. Opening & welcome	Ward Council-lor	
3. Objectives of the meeting	LWSC	To hear the community's opinion about the WWTP
4. Introduction to the project	CES	Overview of what has been done so far in LWWP
5. The community has the word (15min/topic):	Facilitated by LWSC and CES	
(1) List of problems / nuisances caused by WWTP		1. Sometimes in the night, WWTP releases wastewater into the Garden stream / Theater stream, but as drains are blocked by solid waste, the water flows into their compounds and houses; this is even worse during rain season. 2. Smell nuisance esp. in the morning and in the evening 3. LWSC doesn't answer to their complaints – they feel like 'kept in slavery' by the WWTP. 4. They do not have flush toilets, and are not connected to the WWTP; wastewater comes from far places in Lusaka to their place. 5. Water pipes are laid, but no water arrives; women in Garden community demonstrated against the lack of drinking water; they want to fetch water from the taps in the WWTP compound, but they are not allowed to do so. 6. Mosquitos bring diseases 7. When the WWTP was build, nobody lived here; now that the community has grown, the WWTP including the Garden ponds should be moved to Ngwerere outside of town.
(2) Handling of solid waste in the community		1. As there is no maintenance of the WWTP people get used / are taking advantage to throw garbage across the fence wall. 2. Solid waste management is in general a problem in the communities surrounding the WWTP.

Activity	Responsible	Content
		3. We are sorry for this garbage all over the community. 4. Some people just store their garbage during the day and burn it in the night. 5. People cannot afford to pay the garbage collection fee
(3) Handling of wastewater in the community		1. Wastewater is disposed of just on the road (in the newly build drains (which also receive a lot of solid waste) 2. Some dispose their wastewater into the pit latrines 3. Those who have flushable toilets have septic tanks 4. Stagnant water in the drains due to solid waste; resulting in smell and mosquitoes 5. Pit latrines smell, too.
(4) Alternative locations for WWTP		1. Move any treatment to Ngwerere, because there are less people and there is farmland 2. In Chunga, there are also a lot of people living; they probably also do not want the WWTP. 3. If WWTP and Garden ponds would be dismissed, we would have place for more houses, a stadium, a secondary school and a market 4. If it will not be moved, it should be improved
(5) Proposals for improvements at WWTP		1. When the WWTP was still operating, there was no smell and less mosquitos 2. Garden ponds before where clean and nice 3. Install new / up to date technologies 4. Reduce the space occupied by the WWTP to give more place for new houses 5. Cover the drains to hinder solid waste to enter and block the drains; 6. Stop flooding of sewerage 7. Just move it out of our communities; only when / if our demands would be fulfilled we could accept it 8. Tired of meetings; they want understandable explanations about the project 9. They have no money and are not willing to pay for any fees (sanitation, solid waste, water), because they are suffering under the WWTP and the Garden Ponds. 10. Women: we will not sell our houses, because we would not have another place to go and build a new house 11. Men: if the money offered / paid for their houses, they would agree to be resettled. 12. LWSC should have to find a new area, build houses and resettle the community: but in general, they do not want to be resettled. They want to stay
(6) List of opportunities from		They could / would accept to live with the WWTP in

Activity	Responsible	Content
WWTP		their neighborhood, if 1. there would be employment for them 2. their houses would be connected to the sewer line *(but very often there is no space to connect the house to the sewer)* 3. water supply would be reliable and permanent 4. they would benefit from a discount of tariffs for water, sanitation and solid waste collection 5. roads in the community would be improved 6. LWSC would support social community projects such as: schools, clinics, solid waste collection, improved roads, mosquito net distribution and periodical spraying 7. Electricity from biogas production would stop / reduce blackouts in the communities
6. The next steps in the process &	CES; LWSC	After community meetings the consultant will write a report for decision makers; the decision later this year will be presented in another meeting.
7. Closing of the meeting	Ward Councilor	Several participants claimed that the ward councilor is 'invisible' and not close enough to the community

Subject: Community Meeting Chunga WWTP

Location: St. Stephen's Church, Chunga
Date: 11 September 2015

Time: 14.30 – 17.00 hrs

27 persons (7 women and 20 men) attending from Chunga community *(refer to participant list)*

Agenda & information gathered

Activity	Responsible	Content
1. Registration of Participants	CES	Refer to participant list
2. Opening & welcome	Ward Councillor	
3. Objectives of the meeting	LWSC	To hear the community's opinion about the WWTP
4. Introduction to the project	CES	Overview of what has been done so far in LWWP
5. The community has the word (15min/topic):	Facilitated by LWSC and CES	
(1) List of problems / nuisances		1. When residents moved in the community in 1974 the WWTP was well functioning and there was

Activity	Responsible	Content
caused by WWTP		no smell and no mosquitos; the houses were connected to the WWTP and they had reliable water supply to flush the toilets. Since years, the WWTP is not maintained and is emitting smell at any time. 2. They have no permanent water supply, and they cannot flush their toilets anymore. Therefore the sewage is no longer flowing, but stuck in the pipes. 3. Sometimes sewage even flows back into their bathrooms, because of blockages in the pipes. 4. LWSC doesn't answer to their complaints about blockages; and if – they have to pay upfront to make a technician / group of workers to come for de-blockage of the pipes *(Present LWSC staff explained that residents have to pay for de-blockage of pipes inside their plots; LWSC is only responsible for de-blockage in public land (road))*. 5. Residents identify problems with operational policy of LWSC: no maintenance of WWTP and sewer network, no replacement of worn-out equipment and pipes. 6. Local / community based office of LWSC is not linked to LWSC's computer-based customer care system; therefore they cannot follow-up with their complaints and often wait up to 6 months before LWSC takes care of the problems. 7. LWSC also does not maintain water supply infrastructure, neither the pipes nor the tanks. Households do not receive water, but the LWSC water tank is leaking since days, and complaints are not answered! 8. Residents who moved into the community in 1995 experienced a perfect working WWTP during 5 years, water supply and sewerage services. Since then the community grew significantly, but LWSC services (both water supply and sewerage) were not extended in the same pace. This has led to the current problems. 9. Toilets are blocked, in some houses already more than a year. 10. A lot of mosquitos; and foul smell of different intensity is experienced by the entire community at any moment during day and night. 11. Information given by the Environmental Health Officer working at the Community Clinic: prevalence of diarrhea and typhoid; no cholera case since 5 years. 12. Complaints received by the Ward Councilor: (1) lack of water leads to blockages in sewer pipes; (2) pipes for water supply and for sewerage are too old and not maintained by LWSC
(2) Handling of solid waste in the community		1. Solid waste management is a general problem in the community, although it is collected four times per month. 2. Some people cannot afford to pay the garbage collection fee, which ranges between 10 and 40

Activity	Responsible	Content
		ZMW per household per month, and they just throw the garbage into the open drains, on the roads, into the neighbors' plots, or into the man-holes of the sewer lines. 3. Some people pay only 2 ZMW to garbage collectors, who then dispose the garbage at any place they want, which leads to blockages in the drains and a dirty community. 4. The Ward Development Committees have selected designated places where people should dispose this garbage, but people even do not respect and use these places correctly. 5. Residents want to have more waste bins and drums at the market place; they also propose to open the public toilets at the market in order to stop people urinating and even defecating all over the place. 6. Ward Councilor: the community has given itself a by-law saying that people who are disposing off garbage in public and places not designated for are to be taken to the police and fined or even arrested. Therefore everybody has to be vigilant to keep the community clean. 7. Licensed Community Based Enterprises (CBE) for garbage collection have divided the community into zones of responsibilities; they hire the Ward Council's tractor for garbage collection, as they have not enough capital to invest in own equipment. 8. Currently people with money are served, poor households are left aside. 9. The Clinic staff and the Ward Water Committee volunteered to do education on solid waste management to make residents understand that 'garbage is money': an initiative for separating and recycling was proposed by the residents participating in the Community Meeting. 10. Further proposals: (1) WDC should invite more often to problem-centered meetings like the present one, which is not a political one; (2) the Ward Council should facilitate coordination among LWSC field staff, council staff and other organizations (CBEs, CBOs, NGOs) engaged in the communities; (3) WDC and any staff and organizations should support each other in community based educational campaigns in order to achieve improved living conditions for residents; (4) communication between WDC, Ward councils and other organizations (public and private) needs to be improved; (5) for increased relevance the Ward Councilor should call residents to participate in sensitization and education campaigns
(3) Handling of wastewater in the community		1. Wastewater is disposed of just on the road (in the drains 2. Some dispose their wastewater into the pit latrines 3. Those who have flushable toilets collect the

Activity	Responsible	Content
		waste water in buckets for flushing their toilets 4. Some collect the wastewater to water flowers in their plot
(4) Alternative locations for WWTP		1. No alternative location - residents want the WWTP "to stay" and to be rehabilitated. 2. It should be improved and upgraded, because they want to use (again) the treated sludge as soil improver for flower and vegetable production. 3. Newcomers in the community want to be connected, because long-time residents told them about the benefits they had from the WWTP. 4. Other people took advantage of the WWTP and dismantled the fence.
(5) Proposals for improvements at WWTP		1. Between the 1970ies and 80ies the WWTP was well operating without any smell and mosquitos, and it was a very nice place where people went for photo shooting. They want to have this situation re-installed. 2. Fence around the WWTP has to be re-installed for security and protection of the property. 3. Matero ponds also need to be fenced; before they were clean and nice and had a lot of fish but no mosquitoes. Then people started to catch the fishes and finished them all; now they have a huge problem with mosquitoes. 4. Install up-to-date technologies that allow for energy production from sewerage. As the community experiences very often blackouts / load shadings they ask to have electricity produced from biogas generated the WWTP. 5. To reduce the smell, perhaps LWSC needs to apply chemicals at the WWTP.
(6) List of opportunities from WWTP		1. Power generated at the WWTP and distributed in the community – functioning systems exist in Zambia 2. Connection of all houses to the WWTP sewer network. 3. Reliable water supply services to make the sewage flow. 4. Save and free 'manure' for improved yields on their fields and in their gardens to increase their income from market sale. 5. The rehabilitated WWTP would empower the community through improved nutrition, increased income and environmental cleanliness (facilitating people to pay for garbage collection) 6. Other than the dumpsite, which does not provide any benefit at all to the community (although promised), the WWTP would benefit the locals first, potentially also through job creation. 7. Support to Clinic / community health through mosquito nets and spraying campaigns.

Activity	Responsible	Content
6. The next steps in the process &	CES; LWSC	After community meetings the consultant will write a report for decision makers; the decision later this year will be presented in another meeting.
7. Closing of the meeting	Ward Councilor	1. Committed to support rehabilitation of WWTP 2. Reminded residents to respect public / governmental assets (such as WWTP and its fence), because "we are the public / government". 3. Work together with NGO 'Network for Environmental Concerns' (NECOS) building Urine Diversion Dry Toilets in the community. 4. Request to LWSC to improve services to and communication with the community.

Subject: Community Meeting Ngwerere Ponds

Location: Silvia Masebo Compound, yard of Compound Chairman Mr. Andrew Miti
Date: 12 September 2015

Time: 10.30 – 12.30 hrs

64 persons (39 women and 25 men) attending from Silvia Masebo Compound neighboring Ngwerere Ponds *(refer to participant list)*

Agenda & information gathered

Activity	Responsible	Content
1. Registration of Participants	CES	Refer to participant list
2. Opening & welcome	Compound Chairman	Emphasizes the importance of community participation, esp. the participation of women as they are the ones who suffer most from underdevelopment; visitors are not politicians but want to know the weak points / help the community
3. Objectives of the meeting	LWSC	To hear the community's opinion about the ponds
4. Introduction to the project	CES	Overview of what has been done so far in LWWP
5. The community has the word (15min/topic):	Facilitated by LWSC and CES	
(1) List of problems / nuisances caused by WWTP		1. Ponds receive a lot of rubbish: plastic bottles, condoms, paper. 2. Population is growing and houses are constructed closer to the ponds. 3. A lot of mosquitos and a high prevalence of malaria in the community. 4. In rainy season, ponds are overflowing.

Activity	Responsible	Content
		5. As ponds are not sealed, wastewater from ponds contaminates the shallow wells (3 dug wells, about at 6 m deep). 6. There is often a foul smell emanating from the ponds and affecting the community. 7. In general, the area is water logged, and after rains the temporary pit latrines are overflowing. 8. Children always play around the ponds; as there is no safety measure in place (no fence; fence taken away by residents) already 2 children drowned in the ponds in 2013.
(2) Handling of solid waste in the community		1. Solid waste management is a general problem in the community. 2. Some people burn it, others dug pits in which they throw the garbage, but with heavy rains it is washed out. The wind takes it away and it stops and accumulates at the fence of the neighboring duck farm. 3. They would like to have plastic bags to collect and transport to a designated place but they have no money to pay the collection fee (75% of the community is unemployed).
(3) Handling of wastewater in the community		1. Wastewater is disposed off in the garbage pits; 2. Some pour it on the ground in the bathing enclosure.
(4) Alternative locations for WWTP		1. No alternative location - residents want the ponds “to stay” and to be improved. 2. Residents are sure that LWSC will not find other land to relocate neither the ponds nor them (legalized community since 2008, in process of obtaining deeds) as land is very scarce.
(5) Proposals for improvements at WWTP		1. A fence should be installed for security reasons esp. for preventing children to fall into the ponds, but there should be provision that the vegetable producers can still take water for irrigation from the ponds = no electrical fence. 2. Irrigation water quality should be monitored / improved to make its use safe; also they propose to have secure access to the treated water / effluent of the last pond in order to be sure that they can safely use the treated water. If this access is not directly at the ponds, they propose to have access to the outflow at the end of the treatment process. 3. They are aware that they are officially not allowed to use neither the water from the ponds nor the land which was originally fenced as part of LWSC’s property (up to 10m around the total pond area), but the water is their only source for irrigation of their vegetable production. Otherwise they would have less food and no monetary income. 4. Ponds should be deepened to avoid overflowing during rainy season.

Activity	Responsible	Content
		5. Drainage system around the ponds should be improved and the links between the ponds need to be de-blocked or reconstructed. 6. Application of chemicals at the ponds to reduce mosquitos. 7. Number of fish in the ponds should be increased or maintained; people should understand that fish eat mosquito larvae– so if people catch and eat all fish the amount of mosquitos will increase.
(6) List of opportunities from WWTP		1. There should be employment for men from the operation of the ponds. 2. Reliable and safe drinking water supply services. 3. Safe and free 'irrigation water' for improved yields on their fields to increase their income from market sale. 4. The rehabilitated ponds would empower the community if linked to agricultural training / loans for farming / creating a revolving fund for farming activities. This could be organized through the recently created & registered Women's Club. This club will start poultry farming, tailoring and catering activities, and install a hammer mill. 5. Support to community health through mosquito nets and spraying campaigns. 6. Youth wants to have opportunities for attending secondary / high school (the closest one is about 40 km away); they want jobs in small business such as block making; and claim that there are no opportunities for recreation (sports, football or basket ball grounds)
6. The next steps in the process &	CES; LWSC	After community meetings the consultant will write a report for decision makers; the decision later this year will be presented in another meeting.
7. Closing of the meeting	Compound Chairman	Community is ready to work with the project

Annex 5: Socio-economic Baseline

Table: Socio-economic baseline – Ngwerere Ward (Manchinchi WWTP)

Nr.	Socio-economic parameter	Ngwerere Ward (incl. Chilulu, Garden and Luangwa compounds)
1	**Number of households**	~ 11,000
2	**Area**	Total: ~300 ha
		Thereof: Chilulu compound: ~30 ha; Garden compound: ~240 ha; Luangwa compound: ~30 ha
3	**Number of residents**	~66,000 people
		Thereof: ~33,000 male and 33,000 female residents; among whom about ~10,000 children below the age of 10
3.1	Indigenous people	Lenjes
3.2	Population density	220 people/ha
4	**Infrastructure**	
4.1	Basic Schools; students; teachers	2 Basic Schools: Ngwerere Basic School and Simon Mwansa Kapwepwe Basic School; Pupil to teacher ratio is approximately 45
4.2	Secondary schools; students; teachers	No secondary schools
4.3	Clinics; health centers; their capacities and staff	No clinics and no health centers
4.3.1	Main diseases	Malaria and diarrhoea
4.4	Tarred roads	Approximately 2% of total length of roads is tarred
4.5	Means of transport	Public transport: ~ 92% almost all residents use mini buses
		Private buses and vehicles: ~ 8%
4.6	Water supply	In-house connections ~25%
		Tap in yards ~65%
		Public standpipes ~ 10% (mainly communal taps)
4.7	Electricity	Households: ~ 75% connected
		Public buildings: 100% of schools connected
		Street lights: very few, negligible
4.8	Sanitation systems	Sewer connection available in Garden Site 3 and 4 and part of Luangwa compound: ~ 30%
		Pit latrines: used by ~85% of the households
		Septic tanks: used by 5-10% of the households
5	**Economy**	

Nr.	Socio-economic parameter	Ngwerere Ward (incl. Chilulu, Garden and Luangwa compounds)
5.1	Unemployment %	~ 98%: only about 2% of the residents are in formal employment; no gender specific data available
5.2	Main income sources	Public services and enterprises (paid by government): ~10%
		Private services and enterprises: ~10%
		Self-employed: ~80% (informal small businesses and trading)
6	**Other background information**	
6.1	NGO(s) working with the community	Red Cross, although not very active
6.2	CBO(s); clubs; associations	Zithandizeni College run by community for life long skills
6.3	Churches active in the community	Plenty of churches

Table: Socio-economic baseline – Mwambeshi Ward (Chunga WWTP)

Nr.	Socio-economic parameter	Mwambeshi Ward
1	**Number of households**	Approximately 12,000
2	**Area**	Approximately 135 ha
3	**Number of residents**	~69,000 residents of which ~34,000 are male and ~35,000 are female.
		Approximately 10,000 children are below the age of 10 years
3.1	Indigenous people	Lenjes
3.2	Population density	511.11 people / ha
4	**Infrastructure**	
4.1	Basic Schools; students: teachers	2 Basic Schools; pupil to teacher ratio is approximately 45
4.2	Secondary Schools; students; teachers	No Secondary Schools
4.3	Clinics; health centers and their capacities and staff	No clinics and health centers
4.3.1	Main diseases	Diarrhoea and malaria
4.4	Tarred roads	Approximately 5-10% of all road infrastructure
4.5	Means of transport	Public transport: ~90% of the residents rely on mini buses
		Private buses and vehicles: ~ 10% of residents
4.6	Water supply	In-house connections: 65%
		Tap in yard: 20%
		Public standpipes: 15%
		LWSC water tank: 1 (leaking)
		Boreholes: several individual households – no exact data available
		Shallow wells: several – no exact data available

Nr.	Socio-economic parameter	Mwambeshi Ward
4.7	Electricity	Households: ~85% connected
		Public buildings: 100% connected
		Street lights: None at all
4.8	Sanitation	Sewer connection: 65%
		Pit latrines: 90% - almost all the households have pit latrines as alternative toilet facilities
		Septic tanks: 20%
5	**Economy**	
5.1	Unemployment %	Extremely high, Ward councilor estimates the figure at over 95%
5.2	Main income sources	Public services and enterprises (paid by government): 5%
		Private services and enterprises: 5%
		Self-employed (selling own products (vegetables, flowers) on the market, selling second-hand items etc.): 90%
6	**Other background information**	
6.1	NGOs working with the community	Only one NGP: Network for Environmental Concerns (NECOS – working in sanitation; building urine diversion dry toilets)
6.2	CBO(s); clubs; associations	Community Based Enterprises (CBEs) for each solid waste management zone
6.3	Churches	Many churches

Table: Socio-economic baseline – Silvia Masebo Compound (Ngwerere ponds)

Nr.	Socio-economic parameter	Silvia Masebo Compound
1	**Number of households**	1200
2	**Area**	
3	**Number of residents**	10,000 residents
3.1	Indigenous people	No
3.2	Population density	Not calculated, because area of the compound could not be verified
4	**Infrastructure**	
4.1	Basic Schools; students; teachers	2 basic schools; number of permanent students unknown; 56 teachers
4.1	Secondary schools; students; teachers	No Secondary school; next is in a distance of about 35 km
4.3	Clinics; health centers, their capacities and staff	1 mobile clinic only came once
4.3.1	Main diseases	Diarrhoea, malaria, cholera
4.4	Tarred roads	No
4.5	Means of transport	Public transport: train available
		No private buses and vehicles
4.6	Water supply	In-house connections: 0%
		Tap in yards: 0%
		Public standpipes: 0%
		LWSC water tanks: 0%

Nr.	Socio-economic parameter	Silvia Masebo Compound
		Shallow wells: 3 (about 6m deep)
		Boreholes: 0%
4.7	Electricity	Not at all
4.8	Sanitation	Pit latrines: about 100%, all as temporary constructions
5	**Economy**	
5.1	Unemployment %	At least 75%
5.2	Main income sources	No data accessible
6	**Other background information**	
6.1	NGOs working with the community	Not one
6.2	CBO(s); clubs; associations	Women' Club: not yet funded, but already registered
6.3	Churches	13

Annex 6: Estimated effluent quality and reduction rates - year 2025

Design parameters	Unit	Influent	Treatment target*	Effluent**	Reduction rate (%)
Options 1 and 2, Manchinchi WWTP					
Av. dry weather flow	m^3 /d	57519	n.a	57519	n.a.
BOD_5	kg/d	24596	50 mg/l	1150	95,0%
COD	kg/d	51652	90 mg/l	5177	90,0%
TSS	kg/d	30745	100 mg/l	2301	92,5%
Total Nitrogen	kg/d	4099	n.a.	3074	25,0%
Ammoniacal N	kg/d	2746	10 mg/l	173	93,7%
Total Phosphorous	kg/d	522	n.a.	392	25,0%
PO_4-P	kg/d	350	6 mg/l	262	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100%
Options 1 and 2, Chunga WWTP					
Av. dry weather flow	m^3 /d	25662	n.a	25662	n.a.
BOD_5	kg/d	11348	50 mg/l	513	95,5%
COD	kg/d	23831	90 mg/l	2310	90,3%
TSS	kg/d	14185	100 mg/l	1026	92,8%
Total Nitrogen	kg/d	1891	n.a.	1418	25,0%
Ammoniacal N	kg/d	1267	10 mg/l	77	93,9%
Total Phosphorous	kg/d	298	n.a.	224	25,0%
PO_4-P	kg/d	200	6 mg/l	150	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Option 3					
Av. dry weather flow	m^3 /d	83181	n.a	83181	n.a.
BOD_5	kg/d	35943	50 mg/l	1664	95,4%
COD	kg/d	75480	90 mg/l	7486	90,1%
TSS	kg/d	44929	100 mg/l	3327	92,6%
Total Nitrogen	kg/d	5991	n.a.	4493	25,0%
Ammoniacal N	kg/d	4014	10 mg/l	250	93,8%
Total Phosphorous	kg/d	820	n.a.	615	25,0%
PO_4-P	kg/d	549	6 mg/l	412	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Option 4					
Av. dry weather flow	m^3 /d	95629	n.a	95629	n.a.
BOD_5	kg/d	40678	50 mg/l	1913	95,3%
COD	kg/d	85424	90 mg/l	8607	89,9%
TSS	kg/d	50848	100 mg/l	3825	92,5%
Total Nitrogen	kg/d	6780	n.a.	5085	25,0%
Ammoniacal N	kg/d	4543	10 mg/l	4322	4,9%

Total Phosphorous	kg/d	933	n.a.	700	25,0%
PO_4-P	kg/d	625	6 mg/l	469	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	1000	100,0%
Option 4A					
Av. dry weather flow	m^3 /d	95629	n.a	95629	n.a.
BOD_5	kg/d	40678	50 mg/l	1913	95,3%
COD	kg/d	85424	90 mg/l	8607	89,9%
TSS	kg/d	50848	100 mg/l	3825	92,5%
Total Nitrogen	kg/d	6780	n.a.	5085	25,0%
Ammoniacal N	kg/d	4543	10 mg/l	4322	4,9%
Total Phosphorous	kg/d	933	n.a.	700	25,0%
PO_4-P	kg/d	625	6 mg/l	469	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	1000	100,0%
Option 4B					
Av. dry weather flow	m^3 /d	95629	n.a	95629	n.a.
BOD_5	kg/d	40678	50 mg/l	1913	95,3%
COD	kg/d	85424	90 mg/l	8607	89,9%
TSS	kg/d	50848	100 mg/l	3825	92,5%
Total Nitrogen	kg/d	6780	n.a.	5085	25,0%
Ammoniacal N	kg/d	4543	10 mg/l	287	93,7%
Total Phosphorous	kg/d	933	n.a.	700	25,0%
PO_4-P	kg/d	625	6 mg/l	469	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Option 4C					
Av. dry weather flow	m^3 /d	95629	n.a	95629	n.a.
BOD_5	kg/d	40678	50 mg/l	1913	95,3%
COD	kg/d	85424	90 mg/l	8607	89,9%
TSS	kg/d	50848	100 mg/l	3825	92,5%
Total Nitrogen	kg/d	6780	n.a.	5085	25,0%
Ammoniacal N	kg/d	4543	10 mg/l	287	93,7%
Total Phosphorous	kg/d	933	n.a.	700	25,0%
PO_4-P	kg/d	625	6 mg/l	469	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Option 5 (Chunga and Ngwerere WWTPs)					
Av. dry weather flow	m^3 /d	69967	n.a	69967	n.a.
BOD_5	kg/d	29330	50 mg/l	1015	96,5%
COD	kg/d	61593	90 mg/l	4568	92,6%
TSS	kg/d	36663	100 mg/l	2030	94,5%
Total Nitrogen	kg/d	4889	n.a.	3667	25,0%
Ammoniacal N	kg/d	3276	10 mg/l	152	95,4%
Total Phosphorous	kg/d	635	n.a.	476	25,0%

PO_4-P	kg/d	425	6 mg/l	319	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%

* Effluent criteria 6 month average

**6 month average in cold season

Annex 6 (continuation): Estimated effluent quality and reduction rates - year 2040

Design parameters	Unit	Influent	Treatment target*	Effluent**	Reduction rate (%)
Options 1 and 2, Manchinchi WWTP					
Av. dry weather flow	m^3 /d	87555	n.a	87555	n.a.
BOD_5	kg/d	45800	50 mg/l	1751	96,2%
COD	kg/d	96180	90 mg/l	7880	91,8%
TSS	kg/d	57250	100 mg/l	3502	93,9%
Total Nitrogen	kg/d	7633	n.a.	5725	25,0%
Ammoniacal N	kg/d	5114	10 mg/l	263	94,9%
Total Phosphorous	kg/d	972	n.a.	729	25,0%
PO_4-P	kg/d	651	6 mg/l	488	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Options 1 and 2, Chunga WWTP					
Av. dry weather flow	m^3 /d	50758	n.a	50758	n.a.
BOD_5	kg/d	23027	50 mg/l	1015	95,6%
COD	kg/d	48357	90 mg/l	4568	90,6%
TSS	kg/d	28784	100 mg/l	2030	92,9%
Total Nitrogen	kg/d	3838	n.a.	2879	25,0%
Ammoniacal N	kg/d	2571	10 mg/l	152	94,1%
Total Phosphorous	kg/d	605	n.a.	454	25,0%
PO_4-P	kg/d	405	6 mg/l	304	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Option 3					
Av. dry weather flow	m^3 /d	138313	n.a	138313	n.a.
BOD_5	kg/d	68826	50 mg/l	2766	96,0%
COD	kg/d	144535	90 mg/l	12448	91,4%
TSS	kg/d	86033	100 mg/l	5533	93,6%
Total Nitrogen	kg/d	11471	n.a.	8603	25,0%
Ammoniacal N	kg/d	7686	10 mg/l	415	94,6%
Total Phosphorous	kg/d	1577	n.a.	1183	25,0%
PO_4-P	kg/d	1057	6 mg/l	792	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Option 4					
Av. dry weather flow	m^3 /d	165671	n.a	165671	n.a.

Design parameters	Unit	Influent	Treatment target*	Effluent**	Reduction rate (%)
BOD_5	kg/d	83697	50 mg/l	3313	96,0%
COD	kg/d	175764	90 mg/l	14910	91,5%
TSS	kg/d	104621	100 mg/l	6627	93,7%
Total Nitrogen	kg/d	13950	n.a.	10463	25,0%
Ammoniacal N	kg/d	9347	10 mg/l	8893	4,9%
Total Phosphorous	kg/d	1880	n.a.	1410	25,0%
PO_4-P	kg/d	1260	6 mg/l	945	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	1000	100,0%
Option 4A					
Av. dry weather flow	m^3 /d	165671	n.a	165671	n.a.
BOD_5	kg/d	83697	50 mg/l	3313	96,0%
COD	kg/d	175764	90 mg/l	14910	91,5%
TSS	kg/d	104621	100 mg/l	6627	93,7%
Total Nitrogen	kg/d	13950	n.a.	10463	25,0%
Ammoniacal N	kg/d	9347	10 mg/l	8893	4,9%
Total Phosphorous	kg/d	1880	n.a.	1410	25,0%
PO_4-P	kg/d	1260	6 mg/l	945	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	1000	100,0%
Option 4B					
Av. dry weather flow	m^3 /d	165671	n.a	165671	n.a.
BOD_5	kg/d	83697	50 mg/l	3313	96,0%
COD	kg/d	175764	90 mg/l	14910	91,5%
TSS	kg/d	104621	100 mg/l	6627	93,7%
Total Nitrogen	kg/d	13950	n.a.	10463	25,0%
Ammoniacal N	kg/d	9347	10 mg/l	497	94,7%
Total Phosphorous	kg/d	1880	n.a.	1410	25,0%
PO_4-P	kg/d	1260	6 mg/l	945	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%
Option 4C					
Av. dry weather flow	m^3 /d	165671	n.a	165671	n.a.
BOD_5	kg/d	83697	50 mg/l	3313	96,0%
COD	kg/d	175764	90 mg/l	14910	91,5%
TSS	kg/d	104621	100 mg/l	6627	93,7%
Total Nitrogen	kg/d	13950	n.a.	10463	25,0%
Ammoniacal N	kg/d	9347	10 mg/l	497	94,7%
Total Phosphorous	kg/d	1880	n.a.	1410	25,0%
PO_4-P	kg/d	1260	6 mg/l	945	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%

Design parameters	Unit	Influent	Treatment target*	Effluent**	Reduction rate (%)
Option 5 (Chunga and Ngwerere WWTPs)					
Av. dry weather flow	m^3 /d	114913	n.a	114913	n.a.
BOD_5	kg/d	60670	50 mg/l	1015	98,3%
COD	kg/d	127407	90 mg/l	4568	96,4%
TSS	kg/d	75838	100 mg/l	2030	97,3%
Total Nitrogen	kg/d	10112	n.a.	7584	25,0%
Ammoniacal N	kg/d	6775	10 mg/l	152	97,8%
Total Phosphorous	kg/d	1275	n.a.	956	25,0%
PO_4-P	kg/d	854	6 mg/l	641	25,0%
Faecal coli	MPN/100 ml	$5*10^7$	5000	5000	100,0%

* Effluent criteria 6 month average

**6 month average in cold season

Annex 7: Wastewater generation of 27 industries discharging into the public sewer network

Id	Name of industry	Waste stream	Activities generating wastewater	Flow (units)	Pollutants present (known or suspected)
1	Acacia Breweries Ltd.	1. Main Stream from Production 2. Domestic Stream	Main drink making process Domestic Activities		Null Potential pollutants are extremely high BOD, very high COD, High Chlorides and Sulphates, dissolves solids and highly coloured brownish yellow
2	Mukwa Breweries Ltd.	1. Main Stream from Production 2. Domestic Stream	Main brewing process Domestic Activities		Acid, Maize Grit Potential pollutants are extremely high BOD, very high COD, High Chlorides and Sulphates, dissolves solids and highly coloured brownish yellow
3	National Breweries Ltd.	1. Main Stream from Production 2. Domestic Stream	Main brewing process Domestic Activities		Maize Grit Potential pollutants are extremely high BOD, very high COD, High Chlorides and Sulphates, dissolves solids and highly coloured brownish yellow
4	Zambian Breweries Ltd.	1. Domestic Stream	Domestic Activities		The Plant Is Not Yet Fully Operational Potential pollutants are extremely high BOD, very high COD, High Chlorides and Sulphates, dissolves solids and highly coloured brownish yellow
5	Midlands Breweries Ltd.	1. Packaging Area Stream 2. Brew House Stream 3. Domestic Stream	Opaque beer packaging process Main brewing process Domestic Activities	0.75 l/s 0.3 l/s	Maize Grit, Potential pollutants are extremely high BOD, very high COD, High Chlorides and Sulphates, dissolves solids and highly coloured brownish yellow
6	Capitol Breweries Ltd.				Potential pollutants are extremely high BOD, very high COD, High Chlorides and Sulphates, dissolves solids and highly coloured brownish yellow
7	Californian Beverages Ltd.	1. Drink Production Stream 2. Domestic Stream	Production of carbonated drinks and squashes.		Foreign Bodies Acidic Waste
8	Tangy Drinks Ltd.	no information provided			
9	Heinrich Syndicate Ltd.	1. Domestic Stream 2. Production Stream	Domestic Activities Production Processes		Maize Grit

Id	Name of industry	Waste stream	Activities generating wastewater	Flow (units)	Pollutants present (known or suspected)
10	D. K. Enterprises	1. Domestic Stream 2. Production Stream	Domestic Activities Production Processes		Null
11	Sayyah Foods Ltd.	1. Main Stream from Production 2. Domestic Stream	Production Activities Domestic Activities		Null
12	Parmalat Zambia Plc.	1. Main Stream from Production 2. Domestic Stream	Production Activities Domestic Activities		Fat, Potential pollutants are moderate BOD, heavy oil and grease, high dissolved solids, high suspended solids and High nitrogen
15	Amigo Fast Foods	1. Domestic Stream 2. Production Stream	Domestic Activities Production Processes		Null
14	Yoyo Foods Ltd.	no information provided			
15	Trade Kings Ltd.	1. Alkaline Stream 1 2. Alkaline Stream 2 3. Acidic Stream 4. Domestic Stream	Soap Production Detergent Powder/Paste Production Sweet Production Domestic Activities		1. Acidic and Alkaline Sludge
16	Tiger Feeds Ltd.	1. Domestic Stream 2. Process Stream	Domestic Activities Production Processes - From Boiler and Extruder		None
17	Zamanita Oil Ltd.	1. Domestic Stream 2. Production Stream	Domestic Activities Production Processes		Fats and Oils
18	Crest Chicken Ltd.	1. Domestic Stream 2. Process Stream	Domestic Activities Production Processes		
19	King Quality Meat	1. Domestic Stream 2. Process Stream	Domestic Activities Production Processes		Null
20	Real Meat Products	1. Domestic Stream 2. Process Stream	Domestic Activities Production Processes		

Id	Name of industry	Waste stream	Activities generating wastewater	Flow (units)	Pollutants present (known or suspected)
21	Dulux Paints Ltd.	1. Domestic Stream 2. Process Stream	Domestic Activities Cleaning of Vessels	Normal	Inert Calcium Carbonate Power
22	Prozam Paints Ltd.	1. Domestic Stream 2. Process Stream	Domestic Activities Production Processes		
23	Kansai Plascon Ltd.	no information provided			
24	Zamleather Industries Ltd.				Potential pollutants are high BOD, highly alkaline, highly suspended solids, chromium and highly persistent colour
25	Kembe Tanneries Ltd.				Potential pollutants are high BOD, highly alkaline, highly suspended solids, chromium and highly persistent colour
26	Kleenline Ltd.	1. Domestic Stream 2. Production Stream	Domestic Activities Production Processes		None
27	Pharmanova Ltd.	1. Domestic Stream	Domestic Activities		None

Source: COWI (2015a): Flow Measurement and Sampling Report

Annex 8: Production profile of 27 industries discharging wastewater into the public sewer network

ID	Name of industry	Main products	Production rate	Raw materials used	Consumption rate	Secondary operational inputs
1	Acacia Breweries Ltd	Soft Drinks	1,000,000 cases/y	Sugar Bottles Closures Labels	1,000 t/y 20,000,000 20,000,000 20,000,000	CO_2 Gas, Diesel
2	Mukwa Breweries Ltd	Opaque Beer	140 m³/month	Maize Meal Yeast	22.5 t/month 20 kg/month	Caustic Soda, Grease
3	National Breweries Ltd.	Chibuku Shake Shake Chibuku Super	98,550 m³/y	Maize Meal	14,235 t/y	Null
4	Zambian Breweries Ltd.	Mosi Lager, Castle Lager, Eagle Lager, Castle Light, Black Label, Coca Cola, Fanta Orange, Fanta Grape, Sprite	Null	Water, Maize, Sugar, Yeast, Malt, Hopps	630,000 to 800,000 m³/y	Coal, Acids, Sodium Hydroxide, Lubricants- Oil and Grease, Paints, Steam Mate, Sodium Hypo Chloride, Calcium Hyroxide
5	Midlands Breweries Ltd.	Lusaka Beer (Opaque Beer)	27,375,000 l/y	Maize Meal Malt Lactic Acid Termamyl AMG Yeast	5,256,000 kg/y 2,282 kg/y 273 l/y 273 l/y 2,190 l/y 9,125 kg/y	Caustic Soda, Coal, Diesel
6	Capitol Breweries Ltd.	no information provided				
7	Californian Beverages Ltd.	Carbonated Drinks: Apple Max, Ginger Beer, Hubbly Bubbly, etc, Squashes: Just	20,000 m³/y	Water	70,000 m³/y	Food Grade Lubricants Caustic soda
		Orange, Pineapple		Sugar concentrates (Flavorant) Critric Acid	6,000 MT/y 1,500 m³/y 180 MT/y	
8	Tangy Drinks Ltd.	no information provided				

ID	Name of industry	Main products	Production rate	Raw materials used	Consumption rate	Secondary operational inputs
9	Heinrich Syndicate Ltd.	Super Shake Maheu	250 tonnes	Sugar, Mealie Meal, HDPE		Cleaning Materials, Caustic Soda, Fuel
10	D. K. Enterprises	Drinks	249.6 m3/month	Sugar, Citric Acid, Artificial Sweetener, Concentrates flavours	Null	Paint, Industrial Cleaner, Liquid Detergent, Pool Acid
11	Sayyah Foods Ltd.	Lacto Pasteurised Milk Yogurts	123,000 l 64,000 l 39,000 l	Milk	226,000 l	Caustic Soda Sanitizer
12	Parmalat Zambia Plc.	UHT Milk Pasteurised Milk Lacto UHT Juice Yogurt Cabana	18,919,000 l/y 6,505,544 l/y 3,327,049 l/y 3,222,396 l/y 2,979,319 l/y 2,412,784 l/y	Milk Sugar Concentrates F/Cream Powder Flavours Stabalizers	30,046,417.6 l/y 537.4 t/y 789 t/y 339.8 t/y 4.9 t/y 78.84 t/y	Caustic Soda Hydrogen Perooxide DCIP Acid Grease Hibitol Acid Additive 222
15	Amigo Fast Foods	Crisps Munchos Puffs	48 t/month 3.7 t/month 2.0 t/month	Potatoes Maize Grits Flavours Palm Oil	13 t/month 182 t/month 130 t/month 74 t/month	Null
14	Yoyo Foods Ltd.	no information provided				
15	Trade Kings Ltd.	Soaps, Detergents, Synthetic Detergents(Paste and Washing Powders), Candy (Sweets),		Sulphonic Acid, Sodium Hydroxide, Soda Ash, Fats and Oils, Glucose Sugar		Grease
16	Tiger Feeds Ltd.	Poultry Feeds Dairy Feeds Dog and Fish Feeds	50,000 t/y 5,000 t/y 10,000 t/y	Maize Soya Beans Soya Cake	30,000 t/y 12,000 t/y 8,000 t/y	Sudstem 80, Sudstem 100, Gadus Grease, Engine Oil, Industrial Gear Oil, Light fuel, Diesel

ID	Name of industry	Main products	Production rate	Raw materials used	Consumption rate	Secondary operational inputs
17	Zamanita Oil Ltd.	Edible Vegetable Oil Bottled Water Oil Seed Meal	Null	Oil Seeds Crude Vegetable Oil	Null	Detergents, Lubricants, Boiler Oxygen Scarvange, Anti Corrosion, Anti Scarlant
18	Crest Chicken Ltd.	Chicken Beef Pork Fish	100 t/week 20 t/week 10 t/week 5 t/week (Trade)	Chicken Beef Pork		Printing Ink, Paint, Grease, Cleaning Chemicals, Ammonia
19	King Quality Meat	Beef/Pork Products	Null	Beef, Pork	Null	Typo Bleach, Hand wash
20	Real Meat Products	Hungarian Sausages Polony Viennas Fresh sausage Bacon Fresh Cuts	10 t/d 2 t/d 0.5 t/d 0.3 t/d 0.6 t/d 0.5 t/d	Pork Beef Spices	6 t/d 0.8 t/d 0.5 t/d	Diesel (Genset, Coolers) Teepol (Cleaning agent) Smoke Clean Detergents
21	Dulux Paints Ltd.	Water Based Paints Solvent Based Paints	840 t/d 240 t/d	Emulsion Extenders Additives	58.8 t/y 672 t/y 54 t/y	N/A
				Pigment Solvent L.O.A Resin	75.5 t/y 38.4 t/y 48 t/y	
22	Prozam Paints Limited	Paints	1,248.000 l/y	Calcium Carbonate Titanium Emulsion	600 t/y 16 t/y	
23	Kansai Plascon Ltd.	no information provided				
24	Zamleather Industries Ltd.	no information provided				
25	Kembe Tanneries Ltd.	no information provided				

ID	Name of industry	Main products	Production rate	Raw materials used	Consumption rate	Secondary operational inputs
26	Kleenline Ltd.	Liquid Detergent Disinfectant Shampoo	160 t 8 t 8 t	Sodium Lauryl Ether Sulphate Benzalkonium Chloride Sulphuric Acid Caustic Soda Nonyl Phenol Creyslic Acid Sodium Carbonate Empigen BAC 50	2 t 1 t 20 MT 120 kg 5 kg 120 kg 5 t 1 t	Table Salt Adhesives Fozmatin
27	Pharmanova Ltd.	Baby Lotion, Baby Powder, Baby shampoo, Bottled Water, Bubble Bath, Cocao Butter				

Source: COWI (2015a): Flow Measurement and Sampling Report