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Feasibility Study

Development of standardized baselines for methane recovery from wastewater treatment projects in Uganda

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standardized baselines for methane recovery
from wastewater treatment projects in Uganda

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List of Abbreviations

ABR	Anaerobic Baffle Reactor
BOD	Biochemical Oxygen Demand
BTC	Belgian Development Agency
CDM	Clean Development Mechanism
COD	Chemical Oxygen Demand
CWWTP	Conventional Wastewater Treatment Plant
DNA	Designated National Authority
DOE	Designated Operational Entity
DWD	Directorate of Water Development
DWRM	Directorate of Water Resources Management
EIA	Environmental Impact Assessment
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit
KCC	Kampala City Council
KCCA	Kampala City Council Authority
LECB	Low Emission Capacity Building
MAAIF	Ministry of Agriculture, Animal Industries and Fisheries
MWE	Ministry of Water and Environment
NAMA	Nationally Appropriate Mitigation Actions
NEMA	National Environment Management Authority
NWSC	National Water & Sewerage Corporation
PDD	Project Design Document
PoA	Programme of Activities
PE	Population Equivalents
PRC	Performance Review Committee
RUWASS	Rural Water Supply and Sanitation
SBL	Standardized Baseline
SSP	Sewage Stabilisation Ponds
TBOD	Total Biochemical Oxygen Demand
TCOD	Total Chemical Oxygen Demand
TN	Total Nitrogen
UASB	Up-flow Anaerobic Sludge Blanket
UIRI	Uganda Industrial Research Institute
UCPC	Uganda Cleaner Production Centre
UWASNET	Uganda Water and Sanitation NGO Network
UNBS	Uganda National Bureau of Standards
UNIDO	United Nations Industrial Development Organization
UNFCCC	United Nations Framework Convention on Climate Change
WHO	World Health Organisation
WWT	Wastewater Treatment
WWTP	Wastewater Treatment Plant

1. Executive summary

This report offers recommendations for the development of two Standardized Baselines (SBLs) in Uganda: one for the municipal wastewater sector and one for an industrial wastewater treatment (WWT) sector. These SBLs will provide standardised parameters for the calculation of baseline emissions in methane abatement projects for the WWT sector. An SBL is a vital tool towards reducing the transaction costs and time needed to develop a carbon emission reduction project, as well as providing a platform for international climate finance. Since an SBL has national endorsement it can also support the development of and participation in future mechanisms under the United Nation's Framework Convention on Climate Change (UNFCCC), such as Nationally Appropriate Mitigation Actions (NAMAs).

This feasibility study suggests the establishment of two SBLs using the sectoral approach provided in the *Guidelines for the Establishment of a sector specific standardized baseline,* hereafter referred to as the *Guidelines,*[1] of the UNFCCC, in combination with the CDM methodologies AMS-III.H. '*Methane recovery in wastewater treatment projects' and* AMS-III.I. '*Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems'.*

The Chemical Oxygen Demand (COD) of influent, COD removal efficiency and the volumes of water treated at each installation are the main parameters for establishing a standardized baseline for methane recovery or avoidance in WWT. Both the municipal and industrial sectors have been intensively scrutinised for the availability of data for these WWT performance indicators.

The availability of reliable and recent data needed to calculate SBLs for the municipal, and especially industrial, WWT sectors in Uganda is a challenge. For the municipal sector, data on influent COD (COD_{inflow}) and COD removal efficiency (η_{COD}) have been obtained from the National Water and Sewage Corporation (NWSC). The amount of wastewater discharge per treatment facility has been obtained for most of the facilities. The wastewater discharge is one of the crucial parameters needed for the determination of baseline indicators in the sectoral context.

Data from the industrial sector has proved extremely difficult to obtain. Aggregate data indicates that the highest emission reduction potential lies in the

[1] Guidelines for the establishment of sector specific Standardized Baseline, Version 02.0

leather and sugar sectors. The sugar sector is recommended for development of an SBL since the sector has demonstrated interest in carbon markets (two CDM projects are in the pipeline) and the wastewater from sugar producers contains fewer chemical compounds than that of the leather sector, but still has a high COD inflow. For this, data on the COD inflow, COD removal efficiency and quantity of wastewater treated at each facility have been requested from six main sugar producers, out of which one (Kinyara Sugar factory) has provided all the required data.

Next steps for the establishment of SBLs are a) to continue data collection and fill the identified data gaps through direct engagement with key stakeholders, and b) to establish two SBLs, one for the municipal sector and one for an industrial sector, specifically the sugar industry.

Reading guide

Chapter 2 of this report starts with an introduction to this assignment and background information on the objectives. Chapter 3 comprises an introduction to the wastewater treatment sector in Uganda, including various statistics as well as national regulatory standards and laws in the sector. The procedures and methodological choice for the establishment of the SBLs are included in Chapter 4.

Chapter 5 discusses the baseline situation by considering the available data in the municipal and industrial sectors. It also includes a gap analysis.

Overall conclusions, recommendations and proposed next steps are presented in Chapter 6.

2. Background

The Climate Change Department of the Ugandan Ministry of Water and Environment (MWE), which serves as the Uganda Designated National Authority (DNA) secretariat, is hosting a Clean Development Mechanism (CDM) Capacity Development and Projects Support Project, supported by the Belgian Development Agency (BTC). The project aims to support the identification, development, implementation, registration and monitoring of CDM projects and programmes in Uganda.

In an SBL stakeholder workshop organised by GIZ and held in August 2013 the WWT sector was recommended as a key sector to develop SBLs, in addition to institutional cook stoves that GIZ has since supported. It was proposed that a SBL be developed for methane destruction [2] or avoidance from municipal wastewater and another for an industrial wastewater sector with a high potential for emission reductions. The proposed SBLs would also be beneficial to any proposed Nationally Appropriate Mitigation Actions (NAMAs).

The current assignment to develop SBLs in the WWT sector contributes to this ambition. It is expected that SBLs will help to increase the number of CDM projects in Uganda. The country currently hosts 25 CDM projects/programmes across a range of sectors (Figure 1). Projects in afforestation/reforestation, hydropower and household energy efficiency are most common. There are two projects in WWT: one is registered and focuses on methane avoidance and heat generation at the Sugar Corporation of Uganda Limited[3]. The other is undergoing validation and involves methane capture and utilisation at Nakivubo Wastewater Treatment Plant (WWTP).[4]

[2] Note that methane destruction includes the recovery and re-use of any methane generated and includes all methane abatement activities.

[3] Entitled '*Anaerobic digestion and heat generation at Sugar Corporation of Uganda Limited*'. More details available from the UNFCCC at http://cdm.unfccc.int/Projects/DB/TUEV-RHEIN1367560620.84/view

[4] Entitled 'Nakivubo Wastewater Treatment Plant Methane Capture and Utilisation Project'. More details available from UNFCCC at http://cdm.unfccc.int/Projects/Validation/DB/2IA6NSZ8MXWY1RN2K16H47J74MZOY2/view.html

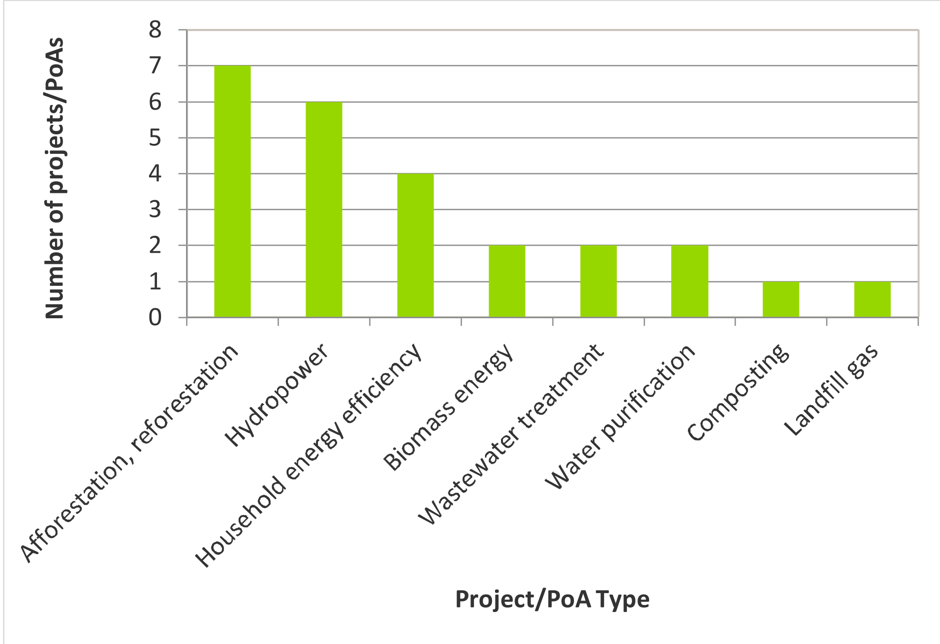


Figure 1: Number of CDM projects or Programme of Activities (PoAs) in Uganda. Includes both registered projects/PoAs and those at validation. [5]

This feasibility study aims to establish the most suitable approach for the development of two SBLs in the WWT sector. It will also assess the quality of data available in order to establish the SBLs, and determine the most suitable industrial sector in which to develop an SBL.

[5] From the UNEP Risoe CDM Pipeline overview and PoA Pipeline overview, Aug 2014, available from http://www.cdmpipeline.org/

3. Wastewater treatment in Uganda

Wastewater producing industries of interest to this study are those that have a high concentration of organic material, coupled with high volumes of water treated. The industrial sugar and leather sectors are therefore most appropriate for development of an SBL, as is the municipal WWT sector.

Wastewater treatment in Uganda is largely inadequate, both in terms of the volumes treated and the quality of the effluent. In Kampala, it is estimated that less than 10% of residents have access to a sewerage system, with the majority of residents making use of on-site sanitation.[6] In towns where a municipal wastewater treatment service is provided, very few facilities meet the national effluent standards. In the industrial sectors, data on the quality and quantity of water treated per premises is very hard to come by.

In both the municipal and industrial sectors, WWT generally follows a basic sequence (**Figure 2**), including: 1) primary treatment, in which solid materials are removed from the water by screening or sedimentation; 2) aerobic or anaerobic biological treatment designed to separate solids from the wastewater. Soluble organic matter is removed from the wastewater using biological processes in which microorganisms consume the organic matter for maintenance and growth.

The resulting biomass and other suspended solids, together known as sludge, are removed from the treated wastewater before the treated wastewater being discharged to a receiving swamp, river or lake.

[6] African Development Fund (2008) *Uganda Kampala Sanitation Programme: Environmental and Social Impact Assessment Summary (ESIA)*

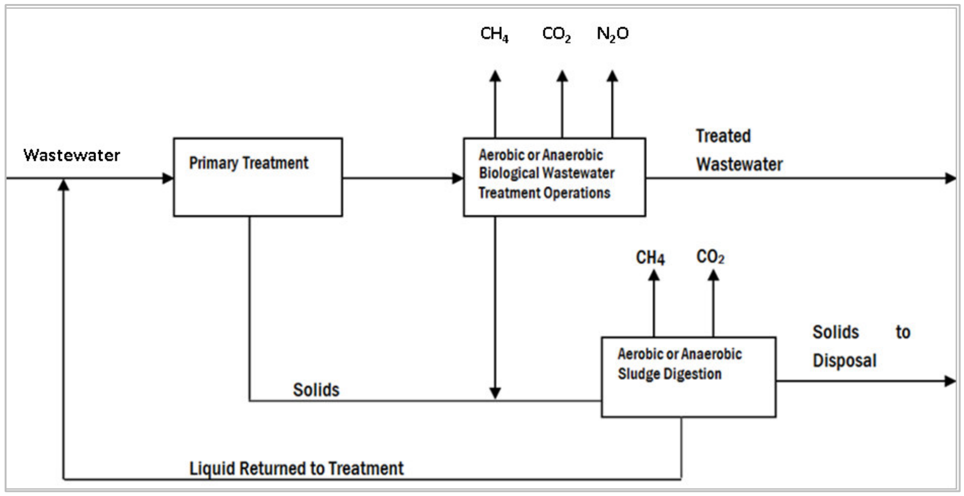


Figure 2: Overview of wastewater treatment inputs and outputs

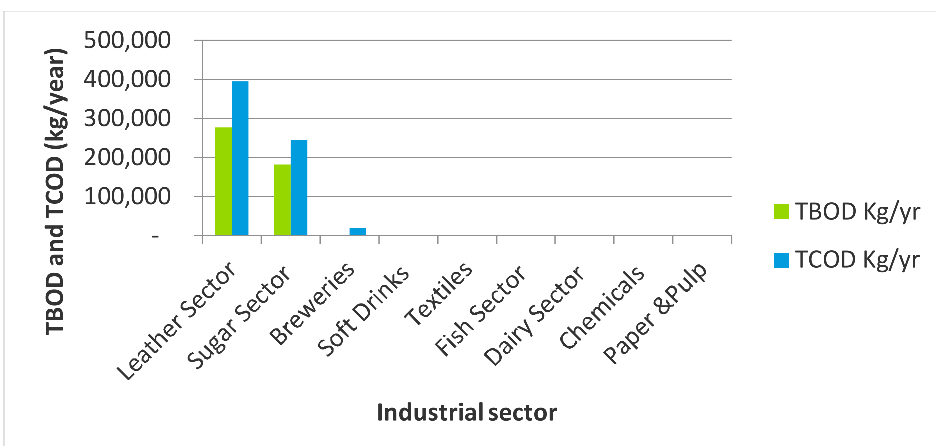
As shown in **Figure 2**, both biological wastewater treatment and sludge digestion generate methane (CH_4) and carbon dioxide (CO_2).

3.1 Wastewater treatment in the industrial sector

Most industries in Uganda are concentrated in Kampala and in Jinja; mainly on the shores of Lake Victoria and the Nile River. The main wastewater producing industries of interest to this study are those that have a high concentration of organic material, coupled with high volumes of water treated. The figure below illustrates the Total Chemical Oxygen Demand (TCOD) and Total Biochemical Oxygen Demand (TBOD)[7] load from different industrial sectors, using 2010 data. The leather and sugar production sectors have the highest loads.

Several facilities and factories have been issued with permits allowing them to discharge treated wastewater. But out of 101 wastewater discharge permit holders, only 73 had treatment facilities as wastewater plants. The actual status of WWT in the industrial sector is furthermore unclear because there is no disaggregated data on wastewater from most of the WWTPs at a number of industries; including leather, sugar, breweries and beverages and textiles.

Figure 3: Industrial Sector Total COD and Total BOD influent load (2010).[8]



[7] FAO: "The biochemical oxygen demand (*BOD*) is defined as the amount of oxygen consumed by microbes in decomposing carbonaceous organic matter. The chemical oxygen demand (*COD*) is the amount of oxygen required to oxidize the organic matter and other reduced compounds. The high chemical versus biological oxygen demand (*COD*/*BOD*) ratios imply significant industrial pollution.", http://www.fao.org/docrep/005/y4263e/y4263e09.htm, accessed 02/11/2015

[8] UCPC sector wise pollution loading analysis on influent 2010.

Obtaining up-to-date data on the industrial wastewater characteristics (COD and BOD inflow and outflows) and treatment practices is challenging. This data can only be obtained through direct engagement with a selected plant, with possible sampling and testing needed to verify any data provided.

In Uganda, industrial wastewater is treated either on site at an industrial facility (industrial wastewater treatment) or in combination with municipal wastewater at a centralised publicly or privately owned treatment plant. For an industry to obtain permission to discharge to a public WWTP (managed primarily by the National Water and Sewerage Corporation, NWSC), they are required to demonstrate minimum effluent standards, provided by NWSC, prior to discharge into the NWSC WWTP.

The most common wastewater treatment systems in industry are lagoons (or Waste Stabilisation Ponds, “low cost” wastewater treatment systems that depend on bacterial activity to remove organic matter, nutrients and microbes in wastewater), mostly used in combination with constructed or natural wetland systems for tertiary treatment. The effluent is ultimately discharged into the natural wetlands, rivers and lakes. Lagoons are designed to eliminate COD/BOD, nitrates, ammonium and phosphates to a certain degree, and have low maintenance requirements.

3.2 Wastewater treatment in the municipal sector

Most wastewater in Uganda is generated from municipal sources. In urban areas, municipal wastewater is either treated at centralised sewage treatment plants or discharged without treatment into the environment. In Kampala and 27 other towns the state-owned National Water and Sewerage Corporation (NWSC) provides sanitation services[9]. The offered service meets the sanitation demand of a relatively small proportion of the urban population. In 2012, only 10% of the population in the working area of NWSC within Kampala had access to sewerage services, leaving 90% of the collected wastewater of Kampala discharged without any treatment.

The NWSC employs two types of sewage treatment systems including the Conventional Wastewater Treatment Plants (CWWTP) and the Waste Stabilisation Ponds (WSP). CWWTP is available only in two sites: at the Bugolobi WWTP for Kampala city (which treats both municipal and industrial wastewater, see Box 1) and at the Masaka WWT.

The CWWTPs consist of a conventional biological treatment systems using primary sedimentation tanks followed by intermediate rate trickling filters and secondary sedimentation tanks. Sludge produced from primary and secondary sedimentation is anaerobically digested before dewatering on sludge drying beds.

The WSPs employed by the NWSC are usually composed of a series of three ponds: anaerobic, facultative and maturation ponds. Anaerobic digestion occurs

[9] NWSC (2013): ANNUAL ACTIVITY REPORT FOR THE FY 2012/13 , Performance Review Report for Period July 2012-June 2013.

in the first pond, aerobic/anaerobic treatment in the second pond and aerobic microbial treatment in the third pond.[10]

Most private residents and enterprises have constructed their own septic tanks as they are not connected to a public sewerage system. The majority of the population however uses affordable pit latrines instead of waterborne systems.

Other than Kampala and Masaka, the NWSC operated WWT plants are all WSPs. Most of NWSC's WWT facilities however do not meet national effluent standards. Assessment of the effluent quality in the receiving waters shows that compliance to effluent standards is rare.[11] This leads to contamination of sources from which drinking water is extracted. The lack of functioning WWT facilities poses a direct threat to human health and the environment.

Box 1: Bugolobi Wastewater Treatment Plant

The Bugolobi WWTP, which is the country’s largest plant, is owned and operated by NWSC. The treatment plant is the only plant that receives both municipal and industrial wastewaters, which are discharged to the sewerage system serving mainly the central areas of Kampala. In addition, the plant receives tankers containing faecal sludge which is co-treated using primary clarification tanks with subsequent trickling filters for the supernatant. The resultant sludge is spread on sludge drying beds for drying.[12]

3.3 Wastewater disposal practices

Wastewater in Uganda is mainly discharged into natural wetlands, rivers and lakes. There is no formal use of the treated effluent in agriculture. The treated sludge is used as a soil conditioner on a small scale. In Kampala, storm water and effluent/treated wastewater is discharged into the Nakivubo wetland.

3.4 National regulations and standards

Uganda has a detailed package of government policies related to water and sanitation. Whilst a legal framework for managing wastewater is in place, enforcement is almost absent. The framework is presented in the tables below.

Table 1: Relevant policies regulating water supply, sewerage and wastewater discharge in Uganda.[13]

POLICY	RELEVANCE TO THE PROJECT
The National Water Policy (1999)	Promotes an integrated approach to manage water resources in the most sustainable and beneficial way.
Environmental Health Policy/National Sanitation Policy (2005)	Reinforces the Public Health Act in ensuring the achievement and maintenance of healthy living conditions in rural and urban areas.
The National Environment (Waste Management) Regulations (1999),	The regulations prohibit the disposal of untreated waste into the environment. Any person intending to run a waste treatment facility may, after carrying out an Environmental

[10] NWSC (no date) *NWSC Sewer Services*, available online: http://www.nwsc.co.ug/index.php/home-mobile/itemlist/category/26-sewer

[11] Assessment of Operation, Maintenance and Performance of the NWSC Sewerage Ponds outside Kampala, GIZ, June 2011.

[12] Fuel potential of faecal sludge: calorific value results from Uganda, Ghana and Senegal, Muspratt et al., 2014

[13] Source: MoWE Reform of the Urban Water and Sanitation Sub-Sector Final Report, May 2011.

Regulations, S.I. No 52/1999.	Impact Assessment (EIA), apply for a license. In carrying out waste treatment, the operator of a waste treatment facility shall take all necessary measures to minimise or prevent pollution from a site or plant.

Table 2: Relevant legal framework regulating water supply, sewerage and wastewater discharge in Uganda.

LEGAL FRAMEWORK	RELEVANCE TO THE PROJECT
The Constitution of the Republic of Uganda (1995)	Guarantees the right of citizens to have access to clean and safe water and sanitation services
The National Environment Act Cap 153(1995)	Provides for the sustainable management of the environment, including water resources. Establishes NEMA as the authority for coordinating, monitoring and supervising the sustainable management of the environment.
The Water Statute (1995) and Water Act (1997).	Provides for the use, protection and management of water resources and development of water supply and sewerage undertakings.
The National Water and Sewerage Corporation Statute, 1995	Establishes the NWSC as a Water and Sewerage Authority and gives it the mandate to operate and provide water and sewerage services in areas entrusted to it on a sound commercial and viable basis.
The Local Government Act (1997) revised in 2000	Provides for decentralisation of services delivery, including water services, to local governments. The Act defines roles for different levels of government in the provision and management of water and sanitation related activities. The Act stipulates provision of water and maintenance of facilities with the local governments in charge; in liaison with the Ministry for Water Affairs. The Act empowers the different levels of government to plan and implement development interventions according to identified local priorities.
Environmental Impact Assessment Regulations (1998)	Outlines the EIA process and the roles of various stakeholders. The Regulations also stipulate it as an offence for any person to commence, proceed or execute any project without approval from NEMA.
The Water (Waste Discharge) Regulations N0.32 1998, Statutory Instrument 152-4	These Regulations prohibit discharge of effluent or waste on land or into the aquatic environment without a waste discharge permit. They also require the installation of “antipollution equipment” as mitigation measures for the treatment of effluent and waste discharge emanating from an industry or establishment. The regulation also requires wastewater producers to arrange for their effluents to be sampled and analysed for monitoring.
Water Resource Regulation (1998)	Provides for water permits for construction and drilling water sources.
The Land Act, 1998	The Land Act vests all rights to water resources in the Government. It empowers the minister responsible for water to regulate the management and utilisation of water. The Act allows for reasonable use by the occupier or owner of a piece of land, of water for domestic and small-scale agricultural purposes.
The National Environment (Standards for Discharge of Effluent into Water or on Land) Regulations, S.I. No 5/1999; this standard is currently under review.	The regulations provide standards of effluent or wastewater that must be achieved before it is discharged into water or land. It also requires the implementing agency to keep records of wastes generated and parameters of the effluent.
Public Health Act (1964) modified in 2000	Urban sanitation is governed by this Act. It empowers the local authorities to carry out inspections of the

LEGAL FRAMEWORK	RELEVANCE TO THE PROJECT
	hygiene and safety standards of public places and households to ensure health, hygiene and safety of the occupants to minimise disease transmission.
The National Environment Act (2000)	Ensures the sustainable use of environmental and natural resources across Uganda.
Ordinances and bye-laws (developed by districts and lower local governments respectively)	These are developed and passed by the local authorities from time to time to address key challenges in service delivery. Some relate directly to water and sanitation services in towns. At the local government level, Kampala City Council (KCC), currently the KCC Authority (KCCA) is the only urban local government which has developed ordinances including the Urban Agriculture Ordinance, 2006, and the Solid Waste Management Ordinance, 2000; to regulate activities in the city in order to have a life worth living. The Urban Agriculture Ordinance has a clause on human waste which prohibits people from using untreated human waste as manure for agriculture purposes. Urban agriculture is still illegal in other municipalities in Uganda.

3.4.1 Effluent discharge standards

The National Environment Regulations, S.I. No 5/1999 (Standards for Discharge of Effluent into Water or on Land) define the standards for the discharge of effluent. **Table 3** outlines the minimum requirements for selected parameters. These standards are currently under review by the Uganda National Bureau of Standards (UNBS).

Table 3: Required effluent quality in minimum discharge standard

PARAMETER	ABBREVIATION	MINIMUM DISCHARGE STANDARD
Biological Oxygen Demand	BOD_5	50 mg/l
Chemical Oxygen Demand	COD	100 mg/l
Total Nitrogen	TN	10 mg/l
Ammonium Nitrogen	NH_4-N	10 mg/l
Nitrate Nitrogen	NO_3-N	20 mg/l
Total Phosphorus	TP	10 mg/l
Phosphate Phosphorus	PO_4-P	5 mg/l

For sludge and other solid waste, there are no standards. However, the Ministry of Agriculture Animal Industries and Fisheries (MAAIF) is developing an Urban Agriculture Policy that will provide guidelines on use of wastewater sludge.

Uganda aims to follow the World Health Organization (WHO) standards for the use of wastewater sludge but the WHO standards are difficult to achieve.

Thus far, there is no regulation in Uganda that requires the implementation of a specific wastewater treatment technology, nor are there laws that forbid the release of methane from wastewater treatment into the atmosphere.

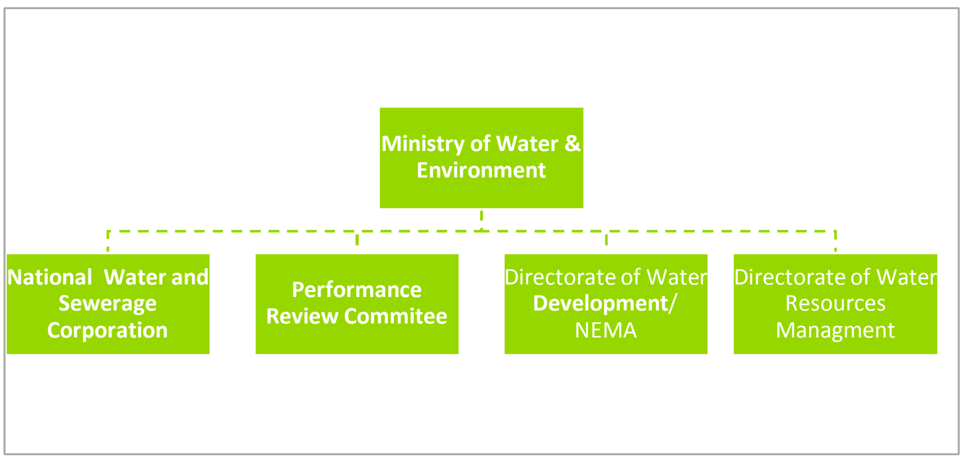
3.5 Law enforcement practices in Uganda

The MWE is the leading governmental agency for formulating national water and sanitation policies (Figure 4). It is supported by the NWSC, the Performance Review Committee (PRC), Directorate of Water Development (DWD), the National Environment Management Authority (NEMA) and the Directorate of Water Resources Management (DWRM). Their responsibilities are as follows:

- NWSC: is a semi-autonomous parastatal that provides water and sewerage services through local private branches, based on a performance contract with the Government of Uganda (GoU). NWSC also monitors wastewater at the premises they service to ensure compliance with the Government's performance contract.
- PRC: reviews the performance of the NWSC based on their Performance Contract with GoU;
- DWD/NEMA: are the main departments responsible for environmental regulations, and act as the executive arm of the MWE. They monitor the quality of the water discharged;
- DWRM: is in charge of permit issuance for business holders and factories that generate effluent with disposal to the environment.

A list of further information on public and private stakeholders involved is summarized in Annex II Table 3.

Figure 4: Law enforcing governmental entities.



NEMA = National Environment Management Authority

The legal framework stipulates the use of economic instruments such as fines and charges for defaulters who do not meet the required effluent charges. There are also instruments that can be applied to create incentives for a given water user or a polluter to strive towards, for example, new technologies or management practices.

However, there are constraints in Uganda's legal and policy framework that limit successful implementation of the regulations outlined above. These are outlined in Table 4.

Table 4: Constraints in the legal and political framework limiting implementation of wastewater regulations

REGULATORY CONSTRAINTS	CAPACITY CONSTRAINTS	DATA CONSTRAINTS
Several effluent\water quality standards are	There are diverse policies that require a multi-	The abstractions and discharges are largely

REGULATORY CONSTRAINTS	CAPACITY CONSTRAINTS	DATA CONSTRAINTS
missing, while the existing ones are either inadequate or overdue for review and harmonisation.[14]	stakeholder cooperative approach	unknown both in terms of locations, water amounts and pollution loads
The sewerage regulation has never been implemented due to incompatibility in principles.	There is low capacity for effective performance monitoring, audits and inspection.	Lack of transparency
Permits for abstraction and wastewater discharge are presently only covering a small percentage of those required to have a permit.		

The abstractions and discharges are largely unknown both in terms of locations, water amounts and pollution loads. This means that the regulatory framework and thus the impact on the water quality are not functioning and the intended control of the water quality is not exercised.

According to MWE (2010), enforcement of the water laws is still a challenge. Studies carried out by MWE revealed that the quality of wastewater sampled from a selected number of discharge points was poor. Only 15% of all samples taken from final effluent points complied with the National Standard for Effluent Discharge for BOD5, 43% of the samples complied with the total suspended solids standard and 52% complied with the fiscal coliforms standard. This results in high pollution of water bodies.

Out of the 89 companies, institutions and organisations that have been issued with wastewater discharge permits, only 39 had valid permits in 2010. Although these companies are operating within the law many are not fully complying with the permit conditions such as:
Measuring and recording wastewater discharges,
Installing wastewater treatment facilities and payment of annual fees

In addition to the conditions specified in the Act and any other law in force, all permit holders are subject to the following general conditions, among others:

- Valid reference dates
- Provision and maintenance of facilities that enable NEMA staff to take discrete or composite samples of final waste effluent which is discharged at the outlet. Identification of the facility with a clearly visible sign distinguishing it from any other.
- Provide the facilities with safe and convenient access to enable NEMA's staff to take samples at any time, carry out flow measurements and inspection to ensure that the conditions of the permit are complied with.

[14] The effluent discharge standards are presently under review by the UNBS

3.6 Methane abatement project scenarios that could use an SBL

The following table lists possible methane formation abatement and methane capture and destruction project scenarios that will be applicable to use the established SBL in combination with the methodology listed below.

Table 5: Project types that could apply the SBL to be established

BASELINE SCENARIO	PROJECT CASE	SOURCE OF EMISSION REDUCTIONS	APPLICABLE SMALL SCALE METHODOLOGY
Degradable organic matter in wastewater is treated in anaerobic systems and methane is emitted	The anaerobic systems (without methane recovery) are substituted by aerobic biological systems	Avoidance of methane formation	AMS-III.I.
Aerobic wastewater or sludge treatment systems	Substitution of aerobic wastewater or sludge treatment systems with anaerobic systems with biogas recovery and combustion[15]	Substitution of non-renewable fuels used for energy/heating with the renewable biogas recovered	AMS-III.H.
Wastewater treatment plant without sludge treatment	Introduction of anaerobic sludge treatment system with biogas recovery and combustion[16]	Substitution of non-renewable fuels used for energy/heating with the renewable biogas recovered	AMS-III.H.
Sludge treatment system without biogas recovery	Introduction of biogas recovery and combustion to a sludge treatment system	Avoidance of methane emissions and substitution of non-renewable fuels used for energy/heating with renewable biogas recovered	AMS-III.H.
Anaerobic WWT system such as anaerobic reactor, lagoon, septic tank or an on-site industrial plant without biogas recovery system	Introduction of biogas recovery and combustion system	Avoidance of methane emissions and substitution of non-renewable fuels used for energy/heating with renewable biogas recovered	AMS-III.H.
Untreated wastewater stream	Introduction of anaerobic WWT with biogas recovery and combustion, with or without anaerobic sludge treatment	Avoidance of methane emissions and substitution of non-renewable fuels used for energy/heating with renewable biogas recovered	AMS-III.H.
Anaerobic WWT system without biogas recovery	Introduction of sequential stage WWT with biogas recovery and combustion, with or without sludge treatment	Avoidance of methane emissions and substitution of non-renewable fuels used for energy/heating with renewable biogas recovered	AMS-III.H.
Anaerobic WWT systems and anaerobic manure management systems with volatile solids from the wastewater or manure slurry stream.	Installation of technologies that avoid or reduce methane production through removal of (volatile) solids from the wastewater or manure slurry stream. The separated solids shall be further treated, used or disposed in a manner resulting in lower methane emissions.	Avoidance or reduction of methane emissions by removing or reducing (volatile) solids from the wastewater stream. This methodology does not allow for recovery and combustion of biogas.	AMS-III.Y.

[15] Emission reductions achieved through substituting non-renewable fuels for energy/heating with the renewable biogas recovered.

[16] ibid.

4. Standardized baseline for wastewater treatment

A standardized baseline (SBL) is a single, standardized estimation of the greenhouse gases that would be emitted if a certain activity was not implemented. Determination of baseline emissions is one of the core tasks under any carbon project. SBLs are useful since they reduce the time, costs and complexity associated with project development. This is especially so when there is not enough historic data to reliably establish a baseline for the project.

The procedure for development of an SBL[17] includes proposing an SBL via the form '*Proposed standardized baseline submission form'* (Version 2.0)[18]. Once this is completed, a Designated Operational Entity (DOE) needs to be hired to validate the SBL. The '*Procedure for development, revision, clarification and update of standardized baselines'* allows countries with 10 or fewer registered CDM projects as of 31 December 2010 to forgo this step for the first three SBL submissions. Thus far, Uganda has submitted two SBLs[19]. A third SBL is expected to be submitted in the near future by GIZ covering institutional cookstoves. Therefore, it is likely a DOE will need to be hired to validate the wastewater SBLs. This involves soliciting proposals for validation of the SBL from DOEs, followed by commencing the validation process, which includes a site visit and exchange of comments and responses. This typically takes 3 – 4 months to complete.

Once all comments from the DOE have been addressed, the Ugandan Designated National Authority (DNA) can approve the SBL and upload the completed Form to the UNFCCC CDM website, including any additional supporting documentation such as data used to establish the baseline and a Letter of Approval. No fee is payable for the submission of the SBL.

The UNFCCC Secretariat will then perform an initial assessment of the submitted documents and provide feedback to the DNA if any additional documentation/evidence is required. If all comments are addressed satisfactorily, the Secretariat will approve the SBL and list it on their website. After this, projects are free to apply the SBL as long as the document is valid. According to the current UNFCCC procedures, SBLs need to be updated and approved every three years.

[17] As per the 'Procedure: Development, revision, clarification and update of standardized baselines' (Version 3.1)

[18] Available from https://cdm.unfccc.int/Reference/PDDs_Forms/index.html#sbs

[19] ASB0002 'Charcoal production for consumption in households and SMEs', 7 October 2013, available from https://cdm.unfccc.int/methodologies/standard_base/new/sb7_index.html

4.1 Methodology

The main purpose of this assignment is to develop an SBL for methane recovery from WWT projects in Uganda. The SBL can be adopted by the UNFCCC as an SBL for the CDM. As of this date voluntary carbon standards (e.g. VCS and The Gold Standard) do not yet have any guidance on the use of SBLs.

According to the procedures for development, revision, clarification and update of standardized baselines[20], an SBL can be developed on the basis of either an approved or a newly submitted methodology, an approved tool, and/or on the basis of the *Guidelines for the Establishment of a sector specific standardized baseline,* hereafter referred to as the *Guidelines*.[21] The main difference between the approaches is that the tools and methodologies usually offer procedures specifically designed for the wastewater sector and widely used by non-Annex I countries for the determination of the baseline, while the *Guidelines* offers a generic methodology applicable to one or more sectors including the WWT sector. For this assignment we propose to use a method that involves the generic approach from the *Guidelines* in combination with an approved methodology designed for WWT projects. The overall approach is further explained under section 4.2.4.

For the development of a standardized baseline, the following elements must be defined:

- **Host country:** Determine the host country to develop a standardized baseline, mainly based on data availability;
- **Sector, output and measure:** Identify the target sectors, output and measures;
- **Positive list and additionality:** Establish additionality criteria for the identified measures (e.g. positive lists of methane abatement technologies);
- **Data requirement:** Identify the baseline for the measures (e.g. Chemical Oxygen Demand (COD) for inflow and COD removal efficiency, volume of water treated, among others);
- **Standardized baseline determination:** Determine the baseline emissions where relevant.

4.1.1 Host country

The selected host country is Uganda. Data availability is an important condition for standardized baseline development. The identified stakeholders in the wastewater sector (listed in Annex) have been screened on data availability. Further analysis on data availability is included under the chapter “Baseline evaluation and gap analysis”.

4.1.2 Sector, output and measure

Specific features of the standardized baseline need to be defined when following the *Guidelines*. These are sector, output and measure.

[20] Development, revision, clarification and update of standardized baselines, Version 3.1

[21] Guidelines for the establishment of sector specific Standardized Baseline, Version 02.0

Sector: is a segment of a national economy that delivers defined output(s) (e.g. clinker manufacturing, domestic / household energy supply). The sector is characterised by the output(s) it generates; the specific sector in this standardized baseline assessment is the wastewater treatment sector that treats wastewater and sludge, and disposes wastewater and sludge with lower Chemical Oxygen Demand (COD) amounts.

Output: are goods or services with comparable quality, properties, and application areas (e.g. clinker, lighting, residential cooking). The output for this specific sector is treated/safer wastewater with lower COD that meets national effluent standards and has less potential for methane emissions generation in anaerobic conditions.

Measure: For emission reduction activities, a broad class of greenhouse gas emission reduction activities possessing common features exists. Four types of measures are currently covered by the standardized baseline framework:

- Fuel and feedstock switch;
- Switch of technology with or without change of energy source (including energy efficiency improvement);
- Methane destruction;
- Methane formation avoidance.

The measures for this assessment are defined as “Methane destruction” and “Methane formation avoidance”. Methane destruction includes all types of technologies that abate methane emissions through control, capture and destruction of methane in the wastewater treatment facilities (i.e. AMS-III.H.). Methane destruction can take place in a methane flare facility or in power and/or heat generation systems. Methane formation avoidance includes avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems (AMS-III.I). Applicable methodologies are further discussed under “Data requirements” section.

4.1.3 Positive list and additionality

A positive list defines a set of criteria that allows any project that meets those criteria to be considered additional. As a rule of thumb, those projects that abate methane in accordance with national legal mandates and requirements cannot be deemed as additional and thus cannot be included in the positive list in the SBL document. Those methane abatement projects within the WWT sector that act beyond the baseline and national legal mandates and requirements can be divided into two main categories:

- Category I: Projects that avoid methane formation or capture and destruct methane through flare systems;
- Category II: Projects that capture and destruct methane through power and/or heat generation;

Under the additionality tool[22] (and after fulfilling basic additionality checks such as the CDM prior consideration test) category I projects are always additional and can be included in the positive list. This is due to the fact that methane formation avoidance and/or methane capture and destruction through flare systems do not bring any additional income to the project proponent without the

[22] Guidelines on the Demonstration of Additionality of Small-Scale Project Activities

CDM. The only income for such projects is known to be the revenue from selling the carbon credits.

Additionality of category II projects is assessed using the additionality tool and the result is dependent on the size of the power/heat generator as well as the local power tariff or cost of the fuel that is displaced. Research shows that power generators in WWT facilities cannot be of large capacity. In most cases they are less than 5 MW in capacity and can be deemed as additional through investment analysis.[23] Due to the fluctuation of capital costs per facility type and the lack of reliable data in the wastewater treatment sector, the process of demonstrating additionality for Category II projects is cumbersome.[24]

The *Guidelines* state that "*If the level of methane destruction undertaken by a measure is higher than what is mandatory and enforced in the area defined under paragraph 34 above, then that measure of methane destruction is additional*" (paragraph 36). This means that the *Guidelines* already offer more lenient criteria for methane abatement projects within the wastewater treatment sector.

Following the *Guidelines*, as long as the abated methane is beyond the national legal mandates and requirements the project can be automatically deemed as additional. To the consultants' knowledge, and after analysing relevant regulations within the sector in Uganda, there is no specific national requirement for methane abatement in the sector. Thus according to the *Guidelines,* it is the view of the consultants that all projects within the wastewater treatment in Uganda can be deemed as automatically additional. Additionality criteria will be developed as part of the development of the two SBLs. These will be assessed by a Designated Operational Entity (DOE) and the UNFCCC Secretariat prior to approval of the SBL.

4.1.4 Data requirements

To determine the methane generated in WWT systems, specific methodological approaches and equations are required. Paragraph 38 of the *Guidelines* refers to monitoring practices for the determination of baseline emissions: "*Baseline emissions may be determined based on the monitoring of the actual amount of methane captured*", this requires the use of approved methodologies in combination with the *Guidelines*. For the establishment of the SBL for the wastewater sector in Uganda a combination of the most suitable methodologies and the *Guidelines* is proposed.

Applicable methodologies for wastewater treatment projects under CDM are AMS-III.H., AMS-III.I. and AMS-III.Y.[25] Under approved small scale methodologies and AM80 and ACM14 under approved large scale methodologies. The following figure shows the result of a statistical analysis carried out on projects that applied the above mentioned methodologies in the

[23] Analysis on wastewater treatment systems available on UNEP DTU pipeline database, last visited 20 November 2014.

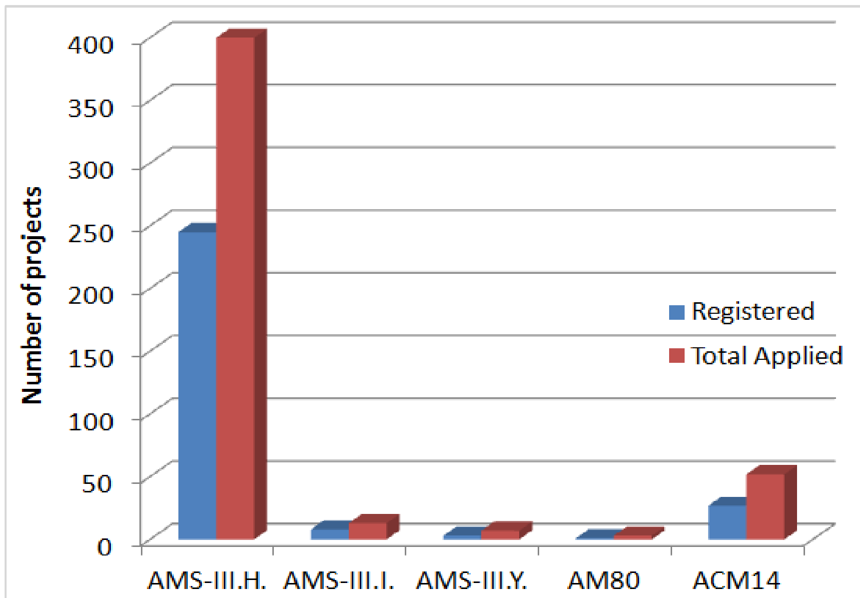
[24] It is noteworthy to mention that the UNFCCC Secretariat has plans to expand the list of positive list for 2015. This list will include wastewater treatment methane abatement projects, both Category I and II. Thus in near future these projects may not need any additionality analysis and may be deemed as automatically additional. For Category II projects there might be a power capacity limit.

[25] Similar to AMS-III.I., AMS-III.Y. does not allow any recovery and combustion of biogas/methane.

CDM pipeline. The analysis included the total number of projects as well as the registered projects in the CDM pipeline.[26]

The figure shows that small scale methodology AMS-III.H. is the most commonly applied methodology. It has been applied in 86% of registered projects and 84% of all the WWT projects in the CDM pipeline. Therefore we propose AMS-III.H. as the most suitable methodology for the SBL establishment. The selection of AMS-III.H. is also in-line with the Terms of Reference for this assignment, which requires the SBLs to be developed under small scale methodologies. In addition, experience shows that most of WWT projects' carbon mitigation potential is below 60,000 $tCO_{2\text{-}e}$ thus AMS-III.H is the most appropriate methodology for this assignment.

Figure 5: Applicable methodologies in the CDM pipeline by November 2014



It is noteworthy to mention that methodology AMS-III.I. "*Avoidance of methane production in wastewater treatment through replacement of anaerobic systems by aerobic systems*" is relevant for this assignment as well. However, since AMS-III.I. follows the same logic for baseline establishment as AMS-III.H., which also covers more project possibilities and has been used more frequently in the wastewater treatment sector, AMS-III.H has been chosen for further analysis in this section. Also the replacement of anaerobic WWT systems with aerobic WWT is still unlikely to be attractive in Uganda in the short to medium term, due to the higher running costs of most aerobic WWT systems. Methodology AMS-III.Y. "*Methane avoidance through separation of solids from wastewater or manure treatment systems*" has the least potential for application among small scale projects as shown in the statistical analysis above, partly because the methodology does not allow for recovery and combustion of biogas. However, in case the treated stream in a project using AMS-III.Y is wastewater (not animal manure steams), there are some elements such as the COD inflow and COD removal efficiency that can be replaced by the SBL developed using AMS-III.H.

[26] UNEP DTU, CDM pipeline, last visited 28 November 2014.

The AMS-III.H. methodology allows the application of different baseline scenarios and offers a straight forward approach for the calculation of baseline emissions. It is crucial in any SBL development to identify the exact parameters that the proposed SBL is going to replace in a methodology.

Table 6 presents different sources of baseline emissions in a WWT system based on methodologies AMS-III.H. and AMS-III.I., and the possibilities for SBL development for each emission source and parameter.

Table 6. Sources of baseline emissions according to AMS-III.H. and AMS-III.I.

BASELINE SOURCE	PARAMETER	FIXED PARAMETERS	PARAMETERS TO BE DETERMINED	RELEVANCE TO SBL DEVELOPMENT
Baseline emissions of the wastewater treatment system	$BE_{ww.treatment}$	Methane Conversion Factor (MCF= IPCC values as per Table III.H.1 of AMS-III.H.); Methane Producing Capacity (B_o=0.25 kg CH_4/kg COD); Model Correction Factor (UF=0.89); Global Warming Potential (GWP=21)	Chemical Oxygen Demand of wastewater inflow (COD_{inflow}) COD removal efficiency of the baseline system (η_{COD})	By determining the COD_{inflow} and η_{COD} this source of baseline emissions can be standardised per m^3 of wastewater inflow.
Baseline emissions of the sludge treatment system	$BE_{s,treatment}$	Methane Conversion Factor (MCF= IPCC values as per Table III.H.1 of AMS-III.H.); Degradable Organic Content (DOC_s=0.5 for domestic sludge and 0.25 for industrial sludge) Model Correction Factor (UF=0.89); Fraction of DOC dissimilated to biogas (DOC_F= 0.5) Fraction of CH_4 in biogas (F=0.5) Global Warming Potential (GWP=21)	None	Not relevant for SBL development. This source of emissions can be directly calculated at the project stage with no significant effort as there is no unknown parameter to be determined;
Baseline methane emissions from degradable organic carbon in treated wastewater discharged into sea/river/lake	$BE_{ww,discharge}$	Methane Conversion Factor (MCF= IPCC values as per Table III.H.1 of AMS-III.H.); Methane Producing Capacity (B_o=0.25 kg CH_4/kg COD); Model Correction Factor (UF=0.89);	Chemical oxygen demand of the treated wastewater discharged into sea, river or lake ($COD_{ww, discharge}$)	Not relevant for SBL development. This source of emissions can be directly calculated at the project stage with no significant effort as there is no unknown parameter to be determined. Uganda

BASELINE SOURCE	PARAMETER	FIXED PARAMETERS	PARAMETERS TO BE DETERMINED	RELEVANCE TO SBL DEVELOPMENT
		Global Warming Potential (GWP=21)		regulates the quality of discharged wastewater after treatment e.g. the National Environment Regulations, S.I. No 5/1999 sets the discharge quality standard at $COD_{outflow}$=100 mg/l, thus this value shall be selected as the baseline COD discharge. Moreover, this parameter can be largely dependent on the type of wastewater flow and the treatment system and can vary significantly even in one sector.
Baseline methane emissions from anaerobic decay of the final sludge produced	$BE_{s,final}$	Methane Conversion Factor (MCF= default as per "Tool to determine methane emissions avoided from disposal of waste at a solid waste disposal site") Degradable Organic Content (DOC_s=0.5 for domestic sludge and 0.25 for industrial sludge) Model Correction Factor (UF=0.89); Fraction of DOC dissimilated to biogas (DOC_F= 0.5) Fraction of CH_4 in biogas (F=0.5) Global Warming Potential (GWP=21)	None	Not relevant for SBL development. This source of emissions can be directly calculated at the project stage with no significant effort as there is no unknown parameter to be determined.
Baseline emissions from electricity or fuel consumption	BE_{power}	Baseline emissions from electricity and fossil fuel consumption shall be determined as per the procedures described in the "Tool to calculate baseline, project and/or leakage emissions from electricity consumption" and "Tool to calculate project or leakage CO_2 emissions from fossil fuel combustion"	This source of emissions is related to the amount of fossil fuel and/or electricity consumption at the facility. This can be measured directly through fuel invoices and/or power bills and cannot be standardised	Not relevant for SBL development. This source of emissions can be directly calculated at the project stage with no significant effort.

BASELINE SOURCE	PARAMETER	FIXED PARAMETERS	PARAMETERS TO BE DETERMINED	RELEVANCE TO SBL DEVELOPMENT
			as it may vary significantly per practice depending on the upper stream sector type.	

According to the above analysis, the most crucial parameters are those used to determine the baseline emissions for wastewater treatment. These are the chemical oxygen demand inflow (COD_{inflow}) and the COD removal efficiency (η_{COD}).

Suppressed demand
In the CDM, baseline emissions are typically established against historic emissions or by comparison to what would have been built without the CDM. In some situations neither of these approaches applies. This is particularly the case in situations where users do not have access or cannot afford technologies that feature in the baseline. For instance households that did not have access to electricity prior to being included in a rural electrification project will have no baseline emissions. Objective emissions due to the implementation of the project seem only to increase. This does not represent a workable baseline scenario for the calculation of the baseline emissions. This issue can be addressed with the CDM concept of 'suppressed demand'. Suppressed demand is the situation where services provided prior to the project (i.e. in the baseline situation) are insufficient to meet the development needs of communities due to poverty or lack of access to technology.

Supressed demand plays an important role for SBL establishment in the wastewater treatment sector. Despite the existence of a regulatory standard for the wastewater discharge quality ($COD_{outflow}$=100mg/l), our analysis shows that the discharged wastewater does not meet the minimum requirements in practice. Thus, in Uganda there is supressed demand in terms of possessing treatment systems that can meet the minimal requirements and standards.

In order to calculate the baseline, parameters for the COD_{inflow} and $COD_{outflow}$ are needed. This allows us to calculate the $COD_{removalefficiency}$; another required parameter for the calculation of baseline emissions. The lower the value for $COD_{outflow}$, the higher the emission reductions for any project using the SBLs will be since this will result in a higher removal efficiency rate (i.e. a higher potential for methane emission reductions). Therefore, it is recommended to use the regulatory standards figure (i.e. 100 mg/l) as the value for the $COD_{outflow}$ parameter. This approach is in line with the UNFCCC's guidance.

4.2 Standardized baseline determination

According to the analysis of section 4.1, in order to determine a standardized baseline for the WWT sector using AMS-III.H., two main parameters need to be determined:

1. Chemical Oxygen Demand inflow (COD_{inflow}); and
2. COD removal efficiency (η_{COD});

Since the purpose of this assignment is to define a national standardized baseline for the municipal and one industrial sector, it is necessary to use a sectoral approach when determining values for the above parameters that can represent the entire municipal and selected industrial sector. In order to achieve this, the *Guidelines* offer a generic approach for the determination of a baseline indicator for a sector.

Under this approach treatment facilities (i.e. business premises) from the same sector (e.g. all sugar industry wastewater treatment facilities) are arranged in descending order of methane generation potential per litre of wastewater treated (e.g. mg CH_4 / litre). Figure 6 illustrates the facility with the highest methane generation per litre of wastewater arranged on the far left, whilst the lowest methane generation potential per litre is arranged on the far right. The width of the bars, or percentage indicators, illustrate the aggregated volume of wastewater generated from a particular facility in the sector. Data on the volume of water treated per facility is therefore also needed to determine an SBL.

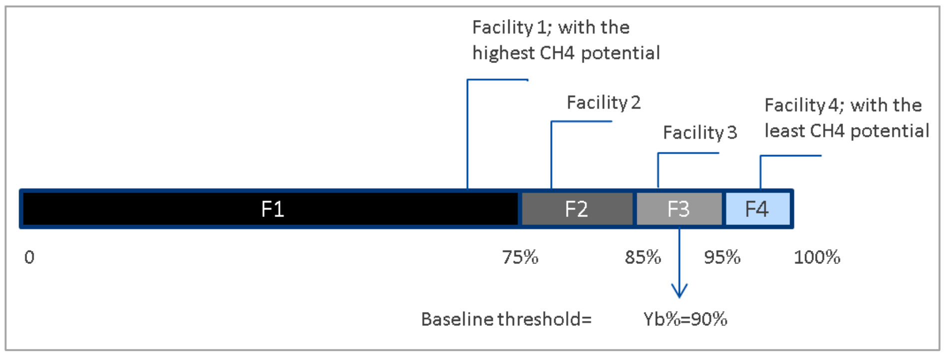


Figure 6. Determination of the baseline per sector. CH4 = methane; Yb% = the baseline threshold

The *Guidelines* set the baseline threshold at 90% of the aggregated volume of wastewater, illustrated as Yb% in **Figure 6**.[27] By using this approach, 90% of the facilities using the baseline will have higher baseline emissions than the SBL. This means that the SBL is relatively conservative, and in our opinion should be voluntary for use. Only 10% of the facilities using the SBL would have lower baseline emissions than the determined SBL. This approach can be repeated both for the municipal sector and the selected industrial sector where relevant.

In the example in Figure 6, Facility F1, which is the most methane emission intensive, comprises 75% of the wastewater generation in the sector. Facilities F2 and F3, each generate 10% of the total wastewater and, together with facility F1, generate 85% and 95% of the total wastewater in the sector. This is more than the baseline (Y_b) thresholds of 90%. Therefore the baseline emissions of facility F3 is determined as the baseline for the sector in the example above.

4.3 Synergies with Ugandan GHG inventories and policies

An SBL can be used to measure the success of any future greenhouse gas mitigation activities in Uganda's wastewater treatment sector. Uganda submitted an initial National Communication to the UNFCCC in 2002. The

[27] The Guidelines set the Yb equal to 90% for sectors other than "Energy for household; Energy generation in isolated systems; and Agriculture".

Communication does not specifically mention the wastewater sector as a priority for mitigation action, but does reference the National Water Policy (1995). This sets out supply and sanitation policies, aiming to encourage the sustainable provision of clean, safe water and sanitation, but no further detail is provided.

In December 2014 Uganda published their second National Communication with support from the Low Emission Capacity Building (LECB) Programme.[28] The country is also working on a National Climate Change Policy in conjunction with the National Communication. The second National Communication outlines the progress in methane avoidance, but does not mention the wastewater sector as a priority for mitigation action. [29].

4.3.1 Nationally Appropriate Mitigation Actions (NAMAs)

The Ugandan Government, through an extensive series of stakeholder consultation and meetings, has prioritised eight sectors for the development of NAMAs. Uganda's first official NAMA submissions to the UNFCCC NAMA Registry are under development and are currently seeking support for preparation.[30]

One NAMA submitted is for agro-processing facilities, entitled "Integrated Wastewater Treatment for Agro-process Water in Uganda". The NAMA includes fish processing factories, livestock slaughterhouses, tanneries, fresh fruit and wine processing plants, and many other facilities that generate large volumes of bio- or agro- process. The NAMA also aims to capture any methane produced from anaerobic wastewater treatment for use in electricity generation, heat or lighting..[31]

It is envisaged that SBLs could potentially assist the development of wastewater treatment projects by saving transaction costs as well as provide a platform to access international climate finance. The SBL also provides a basis for Monitoring/Measuring, Reporting and Verification (MRV) of such a NAMA.

[28] Available from: http://www.lowemissiondevelopment.org/countries/uganda

[29] Ministry of Water and Environment (Climate Change Department) (2014) Uganda Second National Communication to the United Nations Framework Convention on Climate Change, page 130. Available from: http://unfccc.int/resource/docs/natc/uganc2.pdf

[30] UNFCCC NAMA Registry (online) NS-156-Integrated Wastewater Treatment for Agro-process Water in Uganda. Available from: http://bit.ly/12kOWT7

[31] Uganda has prioritised eight NAMAs in different sectors, available from http://bit.ly/1zZNFh4

5. Baseline evaluation and gap analysis

Most data is available for the municipal sector, but the quantity of water treated per facility is pending. In the industrial sector, the sugar sector is most attractive for SBL development due to high methane emissions, but there are considerable data gaps.

Following the analysis performed on data and parameters in Chapter 4, baseline data have been collected from identified stakeholders in both the municipal and a selected industrial WWT sector.

5.1 Municipal sector

For the municipal sector, the main organisation in charge of wastewater laboratory testing and analysis is the NWSC. NWSC collects wastewater performance data including wastewater discharge, COD inflow and COD outflow from 15 municipal wastewater ponds (including Kampala) that they manage throughout the country. Table 7 outlines the data made available by NWSC up until 10 February 2015.

Table 7. Uganda Municipal wastewater discharges in 2012 (NWSC). Note that the negative figures indicate measurement errors and will be excluded from the calculation of the SBL.

TOWNS/ AREA	POND SYSTEMS	POND	WW,Q (M^3/YR)	COD_{IN} (MG/L)	COD_{OUT} (MG/L)	COD REMOVAL EFFICIENCY	WHERE IS THE FINAL TREATED WATER DISCHARGED ?	HOW IS THE REMAINING SLUDGE TREATED?
Entebbe	KITORO	Anaerobic	102,200	520	156	70%	Wetland	Drying
		Anaerobic						
		Anaerobic						
	LUNYO	Anaerobic	73,000	228	244	-7%	Wetland	Drying
		Anaerobic						
		Anaerobic						
Fort portal	Bus PARK	Anaerobic	71,175					

TOWNS/ AREA	POND SYSTEMS	POND	WW,Q (M^3/YR)	COD_{IN} (MG/L)	COD_{OUT} (MG/L)	COD REMOVAL	WHERE IS THE FINAL	HOW IS THE REMAINING
		Anaerobic		1540	860	44%	River Mpanga	Drying
Gulu	PECE FOREST	No Anaerobic Ponds-Only Facultative & Maturation Ponds	198,925	973	360	63%	Wetland	Drying
Hoima	KIGANDA	Anaerobic	128,845	2160	160	93%	Wetland	Drying
Iganga	N/A	All Ponds less than 2m deep.	74,460	1,840	720	61%	Wetland	Drying
Jinja	KIRINYA	Anaerobic	1,617,68	940	310	67%	Lake Victoria	Drying
		Anaerobic		940	230	76%		
	KIMAKA	Anaerobic	691,675	170	110	35%	River Nile	Drying
		Anaerobic		170	100	41%		
Kabale	KIGONGI	Anaerobic	148,190	1499	1090	27%	Wetland	Drying
		Anaerobic		1499	942	37%		
Kampala	NTINDA MINISTER'S VILLAGE	Anaerobic	No data	353	36	90%	Wetland	Drying
	BUGOLOBI PONDS	Anaerobic	4,303,350	493	113	77%	Wetland	Drying
	NAALYA ESTATES	Anaerobic	No data	260	67	74%	Wetland	Drying
	LUBIGI		No data	1385	216	84%	Wetland	Drying
Lira	WESTERN PLANT	Anaerobic	125,925	964	352	63%	Stream	Drying
	EASTERN PLANT	Anaerobic	No data	870	266	69%	Stream	Drying
Masaka	Conventional WWTP		142,350	2,760	2,440	12%	Wetland	Drying
Masindi	KIRASA	Anaerobic	43,800	400	620	-55%	Wetland	Drying
Mbale	DOKO	Anaerobic	502,240	1400	256	82%	Wetland	Drying
		Anaerobic		1400	116	92%		
	NAMATALA	Anaerobic	688,755	400	420	-5%	Wetland	Drying
Mbarara	KIZUNGU	Anaerobic	57,670	718	627	13%	River	Drying
	KAKOBA	Anaerobic	19,601	806	703	13%	River	Drying
	KATETE	Anaerobic	25,806	2262	471	79%	River	Drying

TOWNS/ AREA	POND SYSTEMS	POND	WW,Q (M^3/YR)	COD_{IN} (MG/L)	COD_{OUT} (MG/L)	COD REMOVAL	WHERE IS THE FINAL	HOW IS THE REMAINING
Soroti		No Anaerobic Ponds only. Facultive & Maturation Pond.	144,905	1,300	940	28%	Wetland	Drying
Tororo	MBALE ROAD	Anaerobic	105,120	1040	982	6%	Stream	Drying
		Anaerobic		1040	190	82%		

COD inflow, COD removal efficiency and the quantity of water treated are the most crucial for the SBL development. While concentrations have been reported, the amounts of wastewater discharge per treatment facility are still missing for a few facilities. The data used in the methodology are explained in Chapter 4 (Figure 2).

5.2 Industrial sector

Data from the industrial sector has been collected in parallel to the municipal sector. However it proved extremely difficult to get hold of relevant data. The only useful set of data submitted to us was from the Uganda Cleaner Production Centre (UCPC). UCPC is a joint project of the Government of Uganda, through the Ministry of Tourism, Trade and Industry (MTTI) and the United Nations Industrial Development Organization (UNIDO) to assist the industrial sector to achieve its development goals including their environmental impact management. **Table 8** presents the most relevant data collected from the industrial sector in Uganda thus far.

Table 8. Industrial sector pollution data expressed in total aggregated COD outflow (kg/yr)[32]

INDUSTRIAL SECTOR	TCOD OUTFLOW (KG/Y)
Leather[33]	395,161
Sugar	244,386
Breweries	19,482
Soft Drinks	1,111
Dairy	75
Chemicals	59
Textiles	28
Fish processing	28
Paper & Pulp	22

Preliminary selected industrial sector for SBL development: the industrial sectors listed in the above table are sorted from highest to lowest aggregated COD discharge. The leather and sugar industries have the highest COD outflow. Consequently these two industries supposedly have the highest

[32] UCPC sector wise pollution loading analysis 2010.

[33] This category does not include slaughter houses.

methane emitting potential. Since this assignment is aimed at selecting an industrial sector for the SBL development, one of these two industries would be a good choice.

Whilst COD outflow is higher for the leather sector, much of this is due to the high usage of chemicals during the leather treatment process, specifically chromium.[34] Leather processing involves the production of solid wastes and high amounts of wastewater containing different loads of recalcitrant organic and inorganic pollutants. Effluents from raw hide processing tanneries, which produce wet-blue, crust leather or finished leather, contain compounds of trivalent chromium and sulphides. These compounds require sophisticated removal technologies which often come at a high cost. [35] Simple mechanical and biological technologies, as commonly employed in Uganda, are proven to be inefficient for removal of recalcitrant organics and micro-pollutants in tannery wastewater and often complex oxidation techniques are needed for proper treatment.[36]

Due to the above mentioned technical difficulties, and resulting high up-front investment costs, identified in treating wastewater for the leather industry we recommend development of a SBL for the sugar sector. Since the sugar industry uses fewer chemicals the COD outflow is mainly from biodegradable organic content (which leads to methane emissions). The sugar industry is also more attractive for SBL development since it has demonstrated interest in pursuing carbon market mechanisms: there is one registered CDM project from the Sugar Corporation of Uganda Limited, and another project is at validation.[37] This demonstrates that there is potential for methane avoidance projects under the CDM in similar sugar producing facilities in Uganda.

Table 9 below provides an overview of the main sugar producers in the Uganda. Only five companies account for over 90% of the countries sugar production.

Table 9: Annual output and market share of sugar manufacturers in Uganda

Name of Manufacturer	Estimated sugar output, 2014 ('000 tonnes)	Market Share
Kakira Sugar Works	180	40.68%
Kinyara Sugar Works Ltd.	128	28.93%
Sugar Corporation of Uganda Ltd.	55	12.43%
Sugar & Allied Industries Ltd.	40	9.04%
Sango Bay Estates Ltd.	20	4.52%
Others	19	4.41%
Total (rounded)	**442**	**100.00%**

[34] UNESCO eoloss Library, Wastewater Treatment Technology for Tanning Industry, R. A. Ramanujam, R. Ganesh and J. Kandasamy. Last accessed: 14 January 2015.

[35] GTZ infogate, Treatment of Tannery Wastewater, April 2002.

[36] Chemical and biological treatment technologies for leather tannery chemicals and wastewaters: A review; G. Lofrano, S. Meriç, G. Emel Zengin and D. Orhon, Since of the Total Environment,2013

[37] Project 9620 : Anaerobic digestion and heat generation at Sugar Corporation of Uganda Limited

Data gaps: Table 8 provides useful aggregated COD outflow data. However, data on the total wastewater discharged per facility, the number of facilities and average COD removal efficiency for the selected sector are still required to calculate standardized baseline emissions per unit of wastewater discharge. Data request inquiries have been submitted to above sugar factories. As of this date, so far Kinyara Sugar factory provided a complete set of data to consultants including governmental analytical laboratory approved COD influent, COD effluent and total annual effluent discharge amounts. Other sugar factories are being contacted to submit the same in order to kick off phase II of the assignment and develop SBL documents.

COD laboratory testing: in case the average COD removal efficiency and total wastewater discharge data in the selected sector cannot be identified, COD influent and effluent testing will be needed.

6. Conclusions

Further data is required to elaborate SBLs in both the municipal and industrial sectors. Sampling for wastewater characteristics may be necessary for the sugar sector. Next steps should focus on filling data gaps before proceeding with SBL elaboration.

6.1 Outcomes and recommendations

The main barrier for developing an SBL in the wastewater sectors in Uganda is a consistent lack of reliable and recent data, in particular on industrial wastewater.

Due to the lack of data, not all wastewater treatment sectors are ready for the development of an SBL. More data is available for the municipal sector, but the volumes of water treated are still required for a few facilities. Further data gathering in the wastewater treatment sector is needed.

We recommend selecting the sugar industry for development of a SBL within the industrial sector since it has the highest methane emitting potential.

With regards to the technical aspects of SBL development, the most important outcomes include:

- The baseline indicators per sector should be determined using the sectoral approach provided in the *Guidelines* in combination with AMS-III.H. and AMS-III.I. as a basis for the calculation of the baseline emissions;
- Following the *Guidelines*, as long as the abated methane is beyond the national legal mandates and requirements the project shall be automatically deemed as additional;
- Chemical Oxygen Demand (COD) inflow, COD removal efficiency and the volumes of water treated per facility are the main parameters to consider when establishing the standardized baseline;
- The most suitable methodology for the targeted sector is AMS-III.H. However, the applicability of the SBL will be defined to extend beyond this methodology, to include also CDM methodologies that are (will be) adopted for wastewater treatment systems (e.g. AMS-III.I.);

For the establishment of the standardized baseline for both the municipal and industrial sectors, it is recommended to use the national standards and requirements as the baseline for COD effluent (i.e. 100mg/l). Thus when COD removal efficiency has to be calculated in the SBL calculations, the only missing parameter would be COD influent ($COD_{removal\ efficiency} = [COD_{influent} – COD_{effluent}] / COD_{influent}$).

It is recommended to keep the use of the standardized baseline voluntary as in some specific cases the locally measured indicators may lead to higher methane capture potential (higher baseline emissions).

6.2 Next steps

The opportunity for standardized baseline development for the wastewater treatment sector in Uganda is largely defined by the availability of data. Therefore it is recommended to firstly ensure data completeness. This includes the volumes of wastewater treated in the municipal sector, and the COD inflow and COD removal efficiency and wastewater (influent) discharge values for the sugar sector. This information is necessary before starting with the development of the SBLs.

Whilst it is likely that data for the industrial sector does exist (as Kinyara sugar factory has proven this by submitting the complete sets of required data), accessing that data has been challenging. A workshop was help on 18 – 19 December 2014 to increase understanding of the utility of SBLs and fill the data gaps we have encountered.[38] Follow-up meetings will be arranged during January and February 2015 to further pursue this aim. In case further data is not made available, sampling of wastewater via laboratory testing is required. This could take quite some time, including arranging logistics for the locations of sampling, the number of samples to be taken and analysis of the results. The DWRM has offered consultants to carry out the sampling process for any industrial wastewater treatment facility in Uganda for an officially defined fee.[39] The testing will be done at DWRM's in-house wastewater laboratories. Another option would be to carry out the testing at NWSC laboratories in Kampala.

We will continue the data collection effort until the SBL development phase.

[38] A full list of attendees and feedback recieved is available in Annex II

[39] Consultants were told that the fee per COD sampling and testing is about 16,000 Uganda shilling, excluding logistical costs of getting to and from the test sites.

7 Annexes

7.1 Annex I: Key stakeholders

The main players in the wastewater treatment sector are summarised in the table below. Information presented is based on the interviews held with each organisation, and further investigation during the first stakeholder meeting held early August 2014 in Kampala. The lists are not exhaustive and may expand during this assignment and before/after the stakeholder workshop planned on 18-19 December 2014 in Kampala.

ORGANISATIONS	ROLE AND RESPONSIBILITY	RELEVANCE TO THE ASSIGNMENT
Makerere University	Carrying out academic research mainly in the field of faecal sludge. E.g. using faecal sludge as a source of renewable fuel replacing fossil fuel.	Makerere University has been involved in several wastewater and sludge application research. Some of their data sources may be useful to the current assignment.
Sugar Corporation of Uganda Limited (Lugazi Sugar)	The independent sugar processing industry has no direct role in the wastewater treatment sector apart from their independent treatment facility, which is privately managed. However, this corporation has the only wastewater treatment system that is registered as a CDM project under the UNFCCC. It captures methane in anaerobic conditions and generates renewable heat for sugar processing. Prior to the CDM project, this was sourced from fossil fuels. The project generates up to 46,000 tCO_2 reductions per year.	Some of the wastewater technical features used in the Project Design Document (PDD) of this project might become useful when focusing on a specific industrial sub-sector for the feasibility study. These parameters are COD inflow and COD removal efficiency of the baseline treatment system as well as the treatment type of sludge in the baseline.
National Water and Sewerage Corporation (NWSC)	The NWSC was created as a government-owned parastatal organization in 1972 under the national administration of Idi Amin Dada, serving only the capital Kampala as well as Entebbe and Jinja. Subsequently its service area grew to incorporate large and mid-sized towns all over Uganda, reaching a total of 40 cities and towns in 2014. In 1995 and 2000, it was reorganised under the NWSC Statute and NWSC Act, giving it substantial operational	All new WWT designs could potentially have renewable energy components through anaerobic lagoons and methane capture systems. The old conventional wastewater treatment facilities do not have such options. There are only two conventional wastewater systems (incl. mechanical, biological, chemical etc., treatments in Kampala and Masaka, while the entire WWT systems in major towns under NWSC have waste stabilisation ponds that

ORGANISATIONS	ROLE AND RESPONSIBILITY	RELEVANCE TO THE ASSIGNMENT
	autonomy and the mandate to operate and provide water and sewerage in areas entrusted to it, on a sound, commercial, and viable basis. There is no independent economic regulatory body for water supply. Tariffs are proposed by NWSC and need to be approved by MWE. NWSC is regulated according to a performance contract with the national government. The Performance Review Committee (PRC) under the MWE reviews the performance of NWSC according to the contract. However, the PRC is partly financed by the NWSC, which may stands in conflict with the full independency of the committee. NWSC regulates its local branch offices through internal contracts that are monitored by its internal monitoring and regulation department. NWSC evaluates and monitors performances of private units responsible for management of WWT in major towns outside Kampala. The water quality department of NWSC monitors the WWT process and provides advice to the management of the WWT facilities. In addition, NWSC has data for municipal WWT parameters (CODs & BODs inflows and outflows) from 2005-2009. However, current data on municipal and industrial waste influent and effluents codes could be available with UCPC.	have no or little potential to generate methane emissions in the baseline scenario according to NWSC. Available data on essential parameters shall be availed base on official requests to the management). Given the amount of waste produced and close proximity of the breweries and abattoir to the BSTP, the potential of the three waste types to produce biogas for energy production makes a lot of sense. Based on this background, the different proportions of the three types of waste have been tested for biogas production. NWSC proposed to construct a new sewage treatment plant at Bugolobi. The study carried out may provide an insight into the biogas production potential for optimization and correct projections of the energy production from the new plant, therefore the SBL will offer an added bench mark in the calculations of the green gas emission levels and potential for methane recovery.
Directorate of Water Resources Management (DWRM)	The roles of DWRM can be briefed as following: - Water quality testing: Laboratory testing and analysis of water and wastewater samples for internal purposes and provision of additional services at costs to the public (COD tests: UGX 16,000-30,000 per each WW sample). - Water Resources: Carries out assessments of water quantities (ground and surface water) - WR Regulation and planning: uses data from the 2 departments to regulate usage, abstractions and discharges. - Ground and surface water is regulated through issuance of permits, incl. drilling & construction permits (hydropower etc.) renewable yearly. - DWRM issues wastewater discharge permits according to the defined discharge parameters standards. - DWRM currently have BOD discharge	The national standard/regulation against which the tested effluent is compared is an appropriate benchmark to set the baseline for COD outflow. Since the law does not allow enterprises to have a COD outflow above the assigned benchmark, this can be already considered as an appropriate baseline COD outflow. DWRM has informed us that the allowed COD outflow is 100ppm and all tested effluents are compared with this figure for their compliance check.

ORGANISATIONS	ROLE AND RESPONSIBILITY	RELEVANCE TO THE ASSIGNMENT
	parameters only and plan to include heavy metals and CODs etc., according to the discharge regulations under review. - DWRM has limited access to client's premises and in addition encounter weakness to enforcements on the pretext that the laws require proof beyond reasonable doubts. DWRM has round table dialogues as a means to instigate improvement in performance. In addition DWRM restricts issuance and renewal of permits in the event of non- compliance. - DWRM conducts on-spot monitoring and spot checks as well as self-monitoring of the zonal water management (Mbale, Lira, Kasesse, Masaka etc.). In brief, DWRM is in charge of permit issuance for business holders and factories that generate effluent with disposal to the environment. DWRM holds regular sampling and test of enterprises' effluent and compares it with national standards and regulations. The purpose is to ensure the validity of the issued permits. In case of non-compliance DWRM takes action against the enterprise through the Ministry channels. DWRM has informed us that they have no specific information of the wastewater treatment systems in the sector as they are only interested in wastewater outflow features such as COD outflow that they test regularly. This is due to the fact that the role of DWRM is to make sure the enterprises are in compliance with environmental regulations when it comes to wastewater disposal to environment. The most common type of wastewater/sludge treatment systems available in the sector are conventional treatments systems and wastewater stabilization ponds (lagoons) and complex systems with the breweries depending on the products of the factories etc.	
GIZ Kampala / Reform of the Urban Water and Sanitation Sector (RUWASS)	GIZ has been involved in the assessment of Operation, Maintenance and Performance of the NWSC Sewerage Ponds outside Kampala. We were informed by Fredrick that GIZ has no further information for this assignment besides this specific assessment report that was shared. Despite follow ups and setting a fixed appointment we were not able to meet up with Fredrick after all.	Besides some relevant information in regards to stabilisation ponds for municipal wastewater outside of Kampala including some figures on COD inflow and COD removal efficiency, no further information may be found through GIZ.
Directorate of Water	The DWD under the MWE acts as the	The applied national standards and regulations

ORGANISATIONS	ROLE AND RESPONSIBILITY	RELEVANCE TO THE ASSIGNMENT
Development (DWD)	executive arm and provides support to local governments and other service providers. The DWD is expected to monitor the quality of drinking water provided by NWSC. However, in practice NWSC monitors its drinking water quality internally without any complementary external monitoring. NWSC's internal Quality Control Department examines whether the supplied water complies with the national standards for drinking water, which in turn follows the World Health Organization guidelines. The role of DWD is to develop infrastructures and required regulations standards and policy for water and wastewater projects. DWD is not directly involved in sampling and testing of wastewater quality but supports the DWRM with specific requirements including national standards and applied regulations and policy in the sector. DWD is also responsible for development of polices, standards for water supply systems and WWT and sanitation infrastructures, as well as conduct monitoring and supervisions, strategic planning and resources mobilization in the sector whereas NWSC is solely responsible for implementations and manage over 90% of the WWT systems in large towns and have information on designs and operation and maintenance of the systems. On the other hand, the local governments (LGs) are responsible for those towns and municipalities that do not have sewerage systems but on-site sanitation technologies.	for wastewater can be considered as baseline for effluents or wastewater outflow. The relevance for this assignment is that the effluent requirement can be set equal to the COD outflow that can be used to calculate the COD removal efficiency per sub-sector (in case we can get hold of COD inflow data per sub-sector).
National Environment Management Authority (NEMA)	NEMA is the ultimate authority in endorsing project activities by assessing their environmental impacts including their wastewater effluents. Projects need to apply for an environmental certificate before they can run their business and operate. Environmental Impact Assessment is one of the main requirements for NEMA to decide on issuing such certificates. As soon as the certificate is issued the wastewater effluent quality is regularly checked by the Directorate of Water Resources Monument (DWRM) based in Entebbe to assure that the projects meet the national wastewater standards. If approved the DWRM issues a permit that extends their environmental certificates and allow the	As projects need to submit all their operation and performance documents including wastewater treatment designs to NEMA, the entity is in possession of technical details of wastewater inflow and outflow data including COD inflow and COD removal efficiency for different industrial sector. This information is crucial for the development of SBL. NEMA cooperatively promised to provide the requested data and information. NEMA preliminary suggested that sugar industry and breweries in Uganda have the highest potential for methane generation in the baseline scenario thus appropriate sectors to assess further. However, we will assess more industrial sub-sectors before concluding a

ORGANISATIONS	ROLE AND RESPONSIBILITY	RELEVANCE TO THE ASSIGNMENT
	projects to resume their operation.	specific sector for SBL development for industry.
Uganda Manufacturers Association (UMA)	Despite our contact the meeting was not confirmed during the visit to Kampala end of July 2014. Further follow up may be made, in the event that information gap exists. Through our other interviews it was apparent that UMA will not have detail data and information on wastewater inflow and treatment systems.	It was learnt that UMA is more concern with the finished products from the industries and may have very little or no information about the industrial wastes data managements, which may be of little relevance to the SBL development.
Uganda Water and Sanitation NGO Network (UWASNET)	We were told that this organisation is active in water supply systems. The organisation showed interest in the meeting but despite of several follow ups, they did not confirm to set up any meeting. In addition, focal person of the network expressed further interest for the meeting, but would require time to sanction the meeting with the technical individuals relevant to the meeting who resides and operate from their office outside Kampala. The group leader would be informed and the meeting in question may be arranged at a later stage when deemed necessary.	Uganda Water and Sanitation NGO Network (UWASNET) is the national umbrella organisation for Civil Society Organisations (CSOs) in the Water and Environment sector. UWASNET is crucial in helping government realise its targets of alleviating poverty and achieving Millennium Development Goals (MDGs) through universal access to safe, sustainable water and improved sanitation. UWASNET plays this vital role in partnership with other key sector players such as the Government of Uganda, Development Partners (DP's) and the private sector. UWASNET role appears to be limited to provision and access to water and or improvement of sanitation and no major role in industrial/municipal wastewater management sector except sanitation and faecal sludge elements in small towns as well as involvement in Private Public Sector Partnerships.
World Bank - National Sanitation Working Group (NSWG)	We were told through NWSC that the role of the NSWG is to support policy development, advocate and lobby for sanitation and hygiene in national plans and funding, and support the coordination of institutions and activities for improved sanitation and hygiene services throughout the country.	Not much relevance to the assignment as the sanitation topic is mainly concentrated in domestic sanitation and hygiene. Not much data/information can be found relevance to this assignment. Most of the data and information can be obtained through NWSC (for municipal WWT) and NEMA and UCPC (for industrial WWT).
Uganda Cleaner Production Centre (UCPC) (UNIDO) - Uganda National Bureau of Standards -Industrial Research Corporation	UNIDO and UNEP have joined forces to establish National Cleaner Production Centres (NCPCs) in developing countries and countries with economies in transition. The role of National Cleaner Production Centres is to promote the Cleaner Production strategy in enterprises and government policies, in harmony with local conditions, and to develop local capacity to create and meet Cleaner Production demand throughout the country. The aim primarily is to transfer know-how, not just to technology. The Cleaner	UCPC was established in October 2001, as a joint project of Government of Uganda, through then the Ministry of Tourism, Trade and Industry (MTTI) and United Nations Industrial Development Organization (UNIDO). The initial stages of establishments involved a process of selecting an Institution that was to host UCPC. This process was successfully carried out and Uganda Industrial Research Institute (UIRI) emerged ahead of the Department of Chemistry, Makerere University and consequently UCPC has been hosted by UIRI since 2001.

ORGANISATIONS	ROLE AND RESPONSIBILITY	RELEVANCE TO THE ASSIGNMENT
	Production assessors train and advise their clients on how to find the best solutions for their specific problems. Other activities undertaken by the centres typically fall under the following categories: awareness raising, information exchange, education and training, commitment & partnership building, policy advice and technical assistance. The main objective of UCPC is to introduce Cleaner Production practices to enterprises in Uganda in order to help companies reduce operating costs through increased overall efficiency, especially in the use of materials and energy. UCPC provides advice, technical assistance and training in Cleaner Production. The Centre is providing encouragement and assistance to enterprise, especially industries, to improve their environmental performance, while at the same time, fostering improved competitiveness and profitability. By reducing environmental impacts and cutting waste businesses, especially SMEs, can improve their productivity, save money and remain competitive especially in global markets where growing consumer concern about the environment is already being reflected in purchases of goods.	UCPC has informed us that they have plenty of wastewater treatment performance indicators including COD inflow and COD removal efficiency of different industry sectors. We were told that this information may be shared with the consultants upon an official data request letter from official organisations. UCPC conducted a monitoring survey on the industrial sector in 2010 on key parameters and the report indicates the performance levels of the industries with regards to CODs and BODs with indication of the industrial production and emission levels which can guide narrowing down to industries with the greatest potential for Methane recovery. It is noted that the industrial discharge information is quite sensitive and confidential and permission may need to be sought from the industries. However, documentations which are open for public access has been requested are expected to be provided, following the official data requests.

7.2 Annex II: Stakeholder's feedback

Stakeholders' feedback from the workshop on 18-19 December 2014 in Kampala, facilitated by Hilda Galt and Francis Okello.

Figure 7: List of attendees Day 1 (18 December 2014)

BTC UGANDA

BELGIAN DEVELOPMENT AGENCY

THE REPUBLIC OF UGANDA

MINISTRY OF WATER AND ENVIRONMENT,
CLIMATE CHANGE DEPARTMENT
P.O. BOX 28119, KAMPALA
UGANDA

WASTEWATER SBL WORKSHOP

VENUE: SILVER SPRINGS HOTEL BUGOLOBI
DATE 18TH DECEMBER 2014
TIME

S/N	NAME	ORGANISATION	EMAIL/CONTACT	SIGNATURE
1	JOHN L. BAPTIST	Camco/BTC/CCD	lusjob@yahoo.com	
2	HENRY MUSAZI	UBL	henry.Mugabi@eabl.com	
3	Masete Ivan	UWASNET	imasete@uwasnet.org	
4	Baningi Kabson Rogers	Mukwano group	baningikabsonrogers@yahoo.com	
5	ENOS MALAMBALA	NWSC	Enos.Malambala@nwsc.co.ug	
6	Martin Orwiny.	NWSC	orwinymartin@yahoo.com	
8	Nayan Desai	SCOUL	nayandesai@mehtagroup.com	
9	Tumuheweze Sefriano	Hariss International Ltd (Riham)	Sefriano@rihamgroup.com	
10	Francis Okello	ESC	francis.okello@ecosan.at	
11				
12				

BTC UGANDA

BELGIAN DEVELOPMENT AGENCY

THE REPUBLIC OF UGANDA

MINISTRY OF WATER AND ENVIRONMENT,
CLIMATE CHANGE DEPARTMENT
P.O. BOX 28119, KAMPALA
UGANDA

WASTEWATER SBL WORKSHOP

VENUE: SILVER SPRINGS HOTEL BUGOLOBI
DATE 18TH DECEMBER 2014
TIME

S/N	NAME	ORGANISATION	EMAIL/CONTACT	SIGNATURE
1	MARTIN OJOK	BTC	martin.ojok@ccu.go.ug	
2	KAKEETO JAMES	BTC	jkakeeto@gmail.com	
3	HILDA GALT	CLIMATE FOCUS	h.galt@climatefocus.com	
4	Ronald Tuhesigye	CAMCO/BTC	jronnie@gmail.com	
5	Daniel Lubanga	BTC		
6				
8				
9				
10				
11				
12				

Figure 8: List of attendees Day 2 (19 December 2014)

BTC UGANDA | BELGIAN DEVELOPMENT AGENCY | THE REPUBLIC OF UGANDA | MINISTRY OF WATER AND ENVIRONMENT, CLIMATE CHANGE DEPARTMENT, P.O. BOX 28119, KAMPALA UGANDA

WASTEWATER SBL WORKSHOP

VENUE: SILVER SPRINGS HOTEL BUGOLOBI
DATE 19TH DECEMBER 2014
TIME

S/N	NAME	ORGANISATION	EMAIL/CONTACT	SIGNATURE
1	Barungi Kabson Rogers	Mucwano group	barungikabsonrogers@yahoo.com	[signature]
2	Tumuheveze Seftano	Rihan group	cyprantum@gmail.com	[signature]
3	Masete Ivan	UWASNET	imasete@uwasnet.org	[signature]
4	Ian Barafamu	NWSC	ibarafamu@yahoo.com	[signature]
5	MARTIN OJOK	BTC	martin.ojok@ccu.go.ug	[signature]
6	Martin Owiny	NWSC	owinymartin@yahoo.com	[signature]
8	Enos Malambala	NWSC	Enos.Malambala@nwsc.co.ug	[signature]
9	Nayan Desai	SCOUL	nayandesai@mehtagroup.com	[signature]
10				
11				
12				

Figure 9: Feedback forms received

Name:	BARUNGI KABSON ROGERS
What was your impresssion of the workshop?	The workshop was OK
Did you know anything about standardised baselines before?	NO
What did you learn?	To Calculate and set up a SBL for a waste water treatment Plant.
What could have been done better?	Training Certificates & T.P refund.
Signature:	[signature]

Name:	Banungi Calbson Rogers
What was your impresssion of the workshop?	The workshop was one -
Did you know anything about standardised baselines before?	NO
What did you learn?	How to determine Standardised baselines for a waste water treatment plant
What could have been done better?	—
Signature:	[signature]

Name:	ENOS MALAMBALA
What was your impresssion of the workshop?	The workshop was an eye opener to us as we discovered that organisations and Companies can regain back some of their investment through Carbon Credits trading.
Did you know anything about standardised baselines before?	No
What did you learn?	Calculation of standard baselines Procedure of registering CDM projects for Carbon Credits trading
What could have been done better?	Transport refund and training Certificates should have been provided.
Signature:	[signature]

Name:	Ian Banafamu
What was your impresssion of the workshop?	It was very elaborate on most of the aspects and interactive. Most of the very important topics in having a project registered as CDM were very clear.
Did you know anything about standardised baselines before?	I had an overall picture but not so much to details.
What did you learn?	I leart more about the additionality condition after applicability. It was very unclear before the workshop.
What could have been done better?	A case study practical example where prior to the workshop, consultant identifies a case study probably in the host country and takes us throug the major/crucial stages in the process.
Signature:	

Name:	Martin Orwiny.
What was your impresssion of the workshop?	Very good knowledge (information) delivered
Did you know anything about standardised baselines before?	No
What did you learn?	- Dev't of standardized baselines for waste water in which am involved. - Calculation of Carbon credits.
What could have been done better?	Transport refunds + Certificates of training.
Signature:	

Name:	Mosete Ivan
What was your impresssion of the workshop?	The training content was quite good and informative. it is quite useful to me as an environmentalist. However, the timing of the workshop was bad, since the attendance was poor!
Did you know anything about standardised baselines before?	No, i didnt.
What did you learn?	learnt the importance of having ~~the~~ standardized baselines in reducing pollution and global warming. And the challenges faced in gathering data in Uganda, hence the need for a multi stakeholder approach.
What could have been done better?	- The training was brief, so more time was needed especially for those encountering this for the first time. - The timing of the workshop could have been better than this
Signature:	

Name:	
What was your impresssion of the workshop?	I will Learn on entire CDM process; I will get idea of co-gen. & Waste water (CDM) projects.
Did you know anything about standardised baselines before?	I had little knowledge ~~I~~ had many doubts. Those doubts are cleared now.
What did you learn?	Standard Base Line, How it is calculated, Development of two standardize Base Line municipal & Industrial sector.
What could have been done better?	Could include more presentation, Monitoring & verification process, Selection of DOE, Drafting PDD EPPA etc.
Signature:	Nayan Desai Dy GM-Projects SCOUL.

Name:	Tumuhereze Cyprian
What was your impresssion of the workshop?	It has been wonderful, all presentations were so educative and provides a basis in the management of waste water.
Did you know anything about standardised baselines before?	Somehow, but have gained deeper knowledge.
What did you learn?	Managing/treating waste water while ~~minimising~~ avoiding methane emissions as well.
What could have been done better?	This kind of constructive discussion should continue so long as we shall be able to capture the data and eventually solve problems.
Signature:	Cyprian

Name:	
What was your impresssion of the workshop?	The facilitator explained well during the presentations
Did you know anything about standardised baselines before?	No, but I had heard of Carbon Credits.
What did you learn?	I learnt how to Calculate Carbon credits and Standard baselines
What could have been done better?	They should involve more stakeholders because is was good informance.
Signature:	Mach

Name:	Martin orwiny.
What was your impresssion of the workshop?	~~Cal~~ The presentations especially the calculation of Carbon Credit & The meals.
Did you know anything about standardised baselines before?	No
What did you learn?	Carbon Credit calculations. & Standardization of the BL.
What could have been done better?	–
Signature:	

7.3 Annex III: Effluent measures and standards for wastewater in Uganda

Table 10: Effluent standards for wastewater in Uganda (DWRM, 2014)

PARAMETER	MAX. LIMITS
1,1,1 – Trichloroethane	3.0 mg/l
1,1,2 – Dichlorethyelene	0.2 mg/l
1,1,2 – Trichloroethane	0.06 mg/l
1,2 Dichloroethane	0.04 mg/l
1,3 Dichloropropene	0.2 mg/l
Aluminium	0.5 mg/l
Ammonia Nitrogen	10 mg/l
Arsenic	0.2 mg/l
Barium	10 mg/l
Benzene	0.2 mg/l
BOD_5	50 mg/l
Boron	5 mg/l
Cadmium	0.1 mg/l
Calcium	100 mg/l
Chloride	500 mg/l
Chlorine	1 mg/l
Chromium (total)	1.0 mg/l
Chromium (VI)	0.05 mg/l
Cis – 1,2 - Dichloroethylene	0.4 mg/l
Cobalt	1.0 mg/l
COD	100 mg/l
Coliforms	10000 / 100 ml
Colour	300 TCU
Copper	1.0 mg/l
Cyanide	0.1 mg/l
Detergents	10 mg/l
Dichloromethane	0.2 mg/l
Iron	10 mg/l
Lead	0.1 mg/l
Magnesium	100 mg/l
Manganese	1.0 mg/l
Mercury	0.01 mg/l
Nickel	1.0 mg/l
Nitrate-N	20 mg/l
Nitrite-N	2 mg/l

Nitrogen total	10 mg/l
Oil and Grease	10 mg/l
PH	6.0 – 8.0
Phenols	0.2 mg/l
Phosphate (total)	10 mg/l
Phosphate (soluble)	5 mg/l
Selenium	1.0 mg/l
Silver	0.5 mg/l
Sulphate	500 mg/l
Sulphide	1.0 mg/l
TDS	1200 mg/l
Temperature	20 – 35 ℃
Tetrachloroethylene	0.1 mg/l
Tetrachloromethane	0.02 mg/l
Tin	5 mg/l
TSS	100 mg/l
Trichloroethylene	0.3 mg/l
Turbidity	300 NTU
Zinc	5 mg/l

Table 11: Industrial Sector COD and BOD Pollution load analysis (2010). [40]
:

INDUSTRIAL SECTOR	TBOD KG/YR	TCOD KG/YR	TTN KG/YR
Sugar Sector	181,803.36	244,386.09	2,274.54
Breweries	842.3	19,482.52	604.72
Sewage Lagoons	1,615.88	2,148.43	0
Leather Sector	277,092.5	395,161.05	1,482.91
Dairy Sector	3.62	75.66	14.52
Textiles	16.49	28.13	4.62
Fish Sector	16.49	28.13	4.62
Paper &Pulp	2.08	22.02	0.04
Soft Drinks	143.31	1,111.41	23.13
Chemicals	2.62	59.66	10.02

[40] Source: Uganda Cleaner Production Centre (UCPC) sector wise pollution loading analysis 2010.

Table 12 shows results of effluent monitoring at a lagoon system in Northern Uganda over a 3-year period which show that lagoons do not fulfil any of the standards shown in **Table 10**.

Table 12: Average effluent concentrations (typical lagoon system (6m²/PE), and constructed wetland system (1.7 m^2/PE) Uganda 2004-2006, EcoSan own measurements).

TREATMENT SYSTEM	COD	BOD5	NH4-N	PO4-P
Lagoon	175.7 mg/l	67.3 mg/l	59.9 mg/l	7.4 mg/l
Constructed wetland	60.2 mg/l	19.5 mg/l	4.9 mg/l	7.9 mg/l

Table 13: Municipal wastewater treatment systems in Uganda[41].

MUNICIPALITY	NAME OF WWT SYSTEM	YEAR OF COMMISSIONING	TYPE OF WASTEWATER TREATMENT SYSTEMS	METHANE RECOVERY ?
Entebbe	Kitoro	2007	Ponds-3A-2F-3M in Parallel	No
	Lunyo	2007	Ponds-3A-2F-3M in Parallel	No
Fort Portal	Bus Park	1997	Ponds-2A (Parallel)-IF-1M	No
Gulu	Pece Forest	1993	Ponds-1F-2M in series	No
Hoima	Kiganda	2006	Ponds-1A-1F in series	No
Iganga	Igamba	2008	Ponds-1F-3M in series	No
	Nakavule	2008 (Rehab)	Ponds-1F-1M in series	No
Jinja	Kirinya	1960s	Ponds-2A-1F-2M	No
	Kimaka	1988	Ponds-1A-1A in series	No
Kabale	Kigongi	2003	Ponds-2A (Parallel)-IF	No
Kampala	Ntinda Ministers Village		Ponds-1A-1F-1M	No
	Bugolobi Housing estate		Ponds-1A-1F	No
	Naalya Housing estate		Ponds-1A-1F-1M	
	Lubigi	2014	Ponds – 3A (Parallel)-2F(Parallel	
	Bugolobi	1940s/60s	Conventional	No

41 NWSC report 2011.

MUNICIPALITY	NAME OF WWT SYSTEM	YEAR OF COMMISSIONING	TYPE OF WASTEWATER TREATMENT SYSTEMS	METHANE RECOVERY ?
Lira	Western Plant	1992	Ponds-1A-1F-1M	No
	Eastern Plant	1992	Ponds-1A-1F-1M	No
Masaka	Namujuzi Plant		Conventional	No
	Kasijjagirwa	1991	Ponds-1F-2M	No
Masindi	Kirasa	2008	Ponds-1A-1F-1M	No
Mbale	Doko	1986	Ponds-1A-1F-2M	No
	Namitala	1986	Ponds-1A-1F-1M	No
Mbarara	Kizungu	1991	Ponds-1A-1F-1M	No
	Kakoba	1991	Ponds-1A-1F-1M	No
	Katete	1991	Ponds-1A-1F-1M	No
Soroti	Orwadai	1980s (Rehab)	Ponds-1F-2M in series	No
Tororo	Mbale Road	1988	Ponds-2A (in Parallel)-1F	No

Key: A = Anaerobic Pond; F = Facultative Pond; M = Maturation Pond.

7.4 Annex IV: Wastewater treatment practices

The most common wastewater treatment methods and practices in Uganda are summarised in the following steps and categories[42]:

7.4.1 Pre-treatment

Pre-treatment of wastewater (primary (mechanical) treatment) may be required depending on the chosen treatment system (secondary treatment). It can be considered as a separation of clearly extraneous elements from the wastewater stream. It is designed to remove gross, suspended and floating solids from raw sewage. It includes screening, to trap solid objects and sedimentation by gravity to remove suspended solids.

Primary treatment can reduce the BOD of the incoming wastewater by 20-30% and the total suspended solids by some 50-60%.[43]

Anaerobic reactors: Highly concentrated wastewater may be pre-treated anaerobically, using different types of anaerobic reactors, e.g. up flow anaerobic sludge blanket reactors, anaerobic baffled reactors or anaerobic filters.

An ABR is an improved septic tank with a series of baffles under which the wastewater is forced to flow. The increased contact time with the active biomass (sludge) results in improved treatment. They are designed for COD removal only but not nutrient removal. ABR's are designed for a hydraulic retention time of 40-60 hours to achieve COD concentrations of app. 100-150mg/l.

UASB reactors use the same principle as ABR systems. However, the liquid-solids separation is more effective but requires higher reactors which usually cannot be constructed below ground any more, requiring pumping. Nevertheless, investment costs are less, as they can be designed for Hydraulic Retention Times of 24 hours.

The benefit lies in the elimination rates of COD and BOD, which can be achieved at comparatively low cost. Anaerobic primary treatment shall only be chosen if it does not negatively affect the secondary (usually biological) treatment step. One such possibility would be the case where it can be followed by a secondary treatment step which is supposed to eliminate nitrogen by nitrification / denitrification. Denitrification requires carbon (COD) which may have already been removed in the anaerobic pre-treatment step. Therefore anaerobic pre-treatment may be used for domestic effluents of high concentration if no denitrification is required or for certain industrial effluents, rich in COD and relatively poor in nitrogen.

7.4.2 Secondary treatment

Secondary (biological) treatment removes the dissolved organic matter that escapes primary treatment. This is achieved by microbes consuming the organic matter as food, and converting it to carbon dioxide, water, and energy

[42] ESC Consulting feasibility design reports for Water and Sanitation Development Facility-Central- August 2014.

[43] Worldbank (2014): Introduction to Wastewater Treatment Processes

for their own growth and reproduction. The biological process is then followed by additional settling tanks to remove more of the suspended solids. About 85% of the suspended solids and BOD can be removed by a well running plant with secondary treatment. Secondary treatment technologies include the basic activated sludge process, the variants of pond and constructed wetland systems, trickling filters and other forms of treatment which use biological activity to break down organic matter.

While the treatment principals are the same, typically near natural systems require more space, less energy and produce less excess sludge and vice versa for technical systems.

Near natural – lagoon (Surface-aerated basins)

Lagoons have been the system of choice in African countries; including Uganda for many years, typically comprising a succession of anaerobic, facultative and aerobic ponds. Lagoons, surface-aerated basins, are designed to eliminate COD/BOD, N and P and can achieve 80 to 90 percent removal. The lagoons transfer air into the basins required by the biological oxidation reactions and as the main advantage has low maintenance requirements.

Disadvantages are the high land requirement (typically 6-8m^2 per population equivalent (PE), for higher requirements up to 30^2/PE) as well as the low treatment efficiency.

Near natural – constructed wetlands

Constructed wetlands usually use a filter body (soil, sand) and macrophytes for wastewater treatment. A number of different designs exist, differentiated by the existence of a free water surface in surface flow and subsurface flow and by the direction of flow in vertical and horizontal flow systems.

The most efficient systems use subsurface intermittent flow conditions as these will overcome the lack of dissolved oxygen for nitrification frequently observed at all other types.

Disadvantages are the land area requirements, which for Uganda and vertical sub-surface flow conditions are app. 1.5-2.0m^2/PE and for larger plants the equal distribution of wastewater over the entire surface area of the treatment plant remains problematic. The even distribution usually requires pumps with the associated issues of operation and maintenance.

Combinations

To achieve the required removal rates of COD/BOD, N and P also combinations of technologies are possible and usually implemented in cases where treatment standards are increased over time. Usually technologies performing mechanical, anaerobic treatment, aerobic treatment (removal of COD/BOD and oxidation of ammonia), anoxic treatment (removal of nitrate) are combined into sensible combinations.

Technical – trickling filter

Trickling filters use sessile microorganisms for biological wastewater treatment and are followed by a secondary clarifier to remove excess biological sludge.

They are able to achieve high levels of COD and BOD removal as well as nitrification (if designed accordingly) with relatively little energy. Only energy for pumping wastewater and distributing it on top of the trickling filter is required. The energy demand is usually in the range of 0,5kWh/PE.

The same is valid for rotating biological contactors (RBC's), which are usually used for smaller treatment plants only.

The main disadvantages of trickling filters are the risk for clogging, especially for high organic loads (if filled with slag), possible bio-film loss or insufficient growth (for plastic filling materials). Denitrification requires a submerged or covered anoxic biofilter as a first treatment step and recycling of 70-100% of the flow from the effluent of the trickling filter.
For this reason in case full nitrogen removal is required usually activated sludge plants are preferable.

Technical – activated sludge

Activated sludge treatment plants use floating microorganisms for wastewater treatment. There are a number of different types of activated sludge plants apart from the conventional ones, e.g. sequencing batch reactors (SBR) of membrane bio-reactors (MBR). However all use the same principle of wastewater treatment.

Activated sludge treatment plants are the most flexible treatment systems (in particular SBR) which can be designed for COD/BOD removal, nitrification, denitrification and also biological phosphate removal (activated sludge is the only technology able to perform Bio-P) depending on the requirements.

Their main disadvantages are energy demand (1, 5-5kWh/PE) and required capacities to operate and maintain.

Near natural system require large areas of land, cost-intensive sealing to avoid infiltration of untreated wastewater and huge quantities of media (sand, gravel) in case of constructed wetlands, while technical systems require reinforced structures and electrical and mechanical equipment.
In terms of operation and maintenance costs lagoons are the most cost-beneficial choice, followed by constructed wetlands, trickling filters and activated sludge systems. However the possible treatment efficiency rises with the invested amount.

Combinations

To achieve the required removal rates of COD/BOD, N and P also combinations of technologies are possible and usually implemented in cases where treatment standards are increased over time.

The following combinations are commonly possible practices:

- lagoons + vertical subsurface flow constructed wetlands: achieve COD/BOD removal and nitrification
- UASB/ABR + vertical subsurface flow constructed wetlands: achieve COD/BOD removal and nitrification
- sedimentation + trickling filter + covered trickling filter + recycling: achieve COD/BOD removal, nitrification and denitrification
- sedimentation + vertical subsurface flow constructed wetlands + horizontal or vertical subsurface flow constructed wetland: achieve COD/BOD removal, nitrification and denitrification

7.4.3 Tertiary treatment

The purpose of tertiary treatment is to provide a final treatment stage to further improve the effluent quality before it is discharged to the receiving environment (sea, river, lake, wet lands, ground, etc.).Tertiary treatment can remove more than 99 percent of all the impurities from sewage, producing an effluent of almost drinking-water quality. The related technology can be very cost-intensive, requiring a high level of technical know-how and well trained treatment plant operators, a steady energy supply, and chemicals and specific equipment which may not be readily available.

Examples for treatment are the modification of a conventional secondary treatment plant to remove additional phosphorus and nitrogen.

Disinfection, typically with chlorine, can be the final step before discharge of the effluent. Disinfection is frequently built into treatment plant design, but not effectively practiced, because of the high cost of chlorine or the reduced effectiveness of ultraviolet radiation where the water is not sufficiently clear or free of particles.