UNITED REPUBLIC OF TANZANIA
MINISTRY OF ENERGY

ENERGY AND WATER UTILITIES REGULATORY AUTHORITY (EWURA)

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Energy and Water Utilities Regulatory Authority

GUIDELINES FOR DEVELOPMENT OF NON-REVENUE WATER REDUCTION STRATEGY FOR WATER SUPPLY AND SANITATION AUTHORITIES

AUGUST 2021

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ABBREVIATIONS AND ACRONYMS

BPTs	Break Pressure Tanks
DMA	District Metered Area
DT	District and Township
EWURA	Energy and Water Utilities Regulatory Authority
FY	Financial Year
GIS	Geographic Information System
HPE	High-density polyethylene
ICT	Information and Communication Technology
ILI	Infrastructure Leakage Index
IWA	International Water Association
KPI	Key Performance Indicator
MajIS	Water Utilities Information System
NRW	Non-Revenue Water
PRVs	Pressure Reducing Valves
PVC	Polyvinyl chloride
TBS	Tanzania Bureau of Standards
WMA	Weight and Measures Agency
WSSA	Water Supply and Sanitation Authority

MEASUREMENTS UNITS AND SYMBOLS

%	Percent
km	Kilometer
m^3	cubic meter
m^3/conn/day	Volume/connections/day
m^3/day	cubic meter per day
m^3/km/day	Volume/length /day

FOREWORD

Water is an essential basic need and forms a centre of sustainable development. Improved water supply can boost public health and countries' economic growth and contribute greatly to poverty reduction. The development of water sources and infrastructures to meet the growing water demand requires enormous resources and has been a challenge, in particular, in developing countries. Proper maintenance of the water supply systems and reduction of NRW could be one of important approaches in reducing the gap between water demand and supply.

The annual performance reviews of water utilities conducted by EWURA over the past 12 years have revealed that Water Supply and Sanitation Authorities (WSSAs) registered high levels of Non-Revenue Water (NRW) mainly due to improper practices in managing NRW. This hinders WSSAs in providing adequate water services and denies them significant revenue from the sale of water. Also, the root causes and methods for computation of NRW, and strategies that are designed to curb NRW varies across WSSAs.

In this respect, the Guidelines for development of NRW Reduction Strategy for Water Supply and Sanitation Authorities WSSAs, 2021 have been prepared to guide and equip water utilities on the appropriate approach and tools for managing NRW.

The guidelines prescribe key components embodying NRW in WSSAs' service areas and a step-by-step approach in measuring NRW in each component. Additionally, it provides three tools/templates, namely, a self-assessment matrix tool for identifying key strategic areas to address NRW, a populated template of IWA water balance computation, and a framework template for developing a NRW Reduction Strategy.

I hope that WSSAs will adhere to these Guidelines to ensure they properly manage water losses and thereby reduce NRW in their water service areas for improved operational efficiency.

In conclusion, EWURA wishes to acknowledge inputs provided by various stakeholders towards improving these Guidelines. I wish to convey special thanks to the Ministry of Water, Water Supply and Sanitation Authorities (WSSAs), Tanzania Bureau of Standards (TBS) and the Weights and Measures Agency (WMA) who fully participated in preparing these Guidelines.

Eng. Godfrey H. Chibulunje
Acting Director General
June 2021

1. INTRODUCTION

1.1 Background

The Energy and Water Utilities Regulatory Authority (EWURA) is a multi-sectoral regulatory authority established by the EWURA Act Cap 414 of the laws of Tanzania. EWURA is responsible for technical and economic regulation of the energy and water sectors in Tanzania under Cap 414 and respective sector legislation. In the water sector, EWURA regulates Water Supply and Sanitation Authorities (WSSAs), which are responsible for provision of water supply and sanitation services.

Section 29 of the Water Supply and Sanitation Act 2019 mandate EWURA, among other things, to monitor the performance and quality of service standards of water authorities. Also, EWURA Act Cap 414 requires EWURA to promote technical and economic efficiency in the provision of water services.

At the policy level, the National Water Policy 2002 provides a directive on water demand management through implementation of measures on proper tariff setting (at an economic cost), metering, leakage control and mass education on economical use of water and conservation. It is also directed in the policy to reduce water leakages from domestic water supplies as part of good practice in water resources management. Also, Section 21 of the Water Supply and Sanitation Act 2019, among others, empowers WSSA to meter all production points and customer connections to measure the amount of water produced and supplied to all consumers. Furthermore, paragraph 5.5.3 of the National Five Year Development Plan (2021/22 to 2025/26) provides a National target for reduction of NRW to 20% by 2025/26.

Over the past twelve (12) years, EWURA has been conducting Annual Performance Reviews of the Water Supply and Sanitation Authorities (WSSAs). The reviews have revealed that WSSAs recorded high levels of Non-Revenue Water (NRW) may lead to low levels of efficiency including the increase of production costs, decrease of water sales (revenue), and increase in substantial capital expenditure programmes to meet the ever-increasing water demand. In addition, the review revealed that the root causes and methods for computation of NRW, and strategies used to curb NRW, vary across WSSAs.

In order to systematically reduce NRW, WSSAs requires harmonised tools and approaches to conduct self-audit, compute NRW, and package and budget key strategies into an NRW Reduction Strategy. Equally, WSSAs need to have a harmonious framework of performance indicators and targets to monitor progress in the course of implementing an NRW Reduction Strategy.

These Guidelines provide the water utilities with harmonised tools to systematically identify the root causes, reasons and parts of the water supply system that are prone to NRW. Also, the Guidelines provide WSSAs with a framework for preparing realist strategies for the reduction of NRW in respective water service areas. The Guidelines draw on the experience of international institutions like the International Water Association (IWA) and American Water Works Association (AWWA) in respect to approaches commonly used in managing NRW for water utilities. It is expected that effective utilisation of these Guidelines, and related tools and procedures, will enable WSSAs to reduce NRW and thus improve their operational efficiency. These Guidelines may be reviewed at any time when the review is deemed necessary.

1.2 Objective

The purpose of these Guidelines is to provide WSSAs with harmonised tools for preparation of appropriate strategies for NRW reduction in their water supply service areas.

1.3 Scope

These Guidelines cover two major components that are involved in the management of NRW by showing the applicable approaches for measuring NRW, and strategies commonly used to reduce NRW in the various segments of the WSSA water supply system. The Guidelines, therefore, will be used by WSSAs for:

i. Identifying and measuring NRW in WSSAs' water supply service areas; and
ii. Drawing appropriate NRW reduction strategies that are in line with the identified segments of the WSSA water supply system.

1.4 Structure of the Guidelines

The Guidelines consists of six (6) Sections, including this introductory section. Section 2 provides an overview of the legal framework for the management of NRW where institutions providing policy guidance and regulatory oversight and roles in NRW management are outlined. Section 3 provides WSSAs with appropriate tools for conducting self-assessment with a view of identifying technical, commercial, financial and management practices that influence NRW Management and a step-by-step approach in measuring NRW within their service areas. The section further leads WSSAs in identifying strategies to be implemented in potential areas for NRW reduction. Section 4 brings into context the aspect of NRW and guides WSSAs in developing an implementable NRW Reduction Strategy, which includes priority areas, budget provision, action plan, and targets to be attained in the course of the strategy implementation. Section 5 provides WSSAs with a tool for preparing key performance indicators addressing all components of NRW. Lastly, Section 6 guides WSSAs for proper monitoring and evaluation of the NRW Reduction Strategy.

2. LEGAL FRAMEWORK FOR REDUCTION OF NON-REVENUE WATER

These Guidelines will be successfully implemented if the supporting policy and legal instruments are well known to all stakeholders that are involved in NRW management. This section presents a highlight of key policies and legislations to be noted and complied by WSSAs in the course of implementing the Guidelines.

2.1 National Water Policy 2002

The National Water Policy 2002 provides a guidance on water demand management through the implementation of measures on proper tariff setting (at an economic cost), metering, leakage control and mass education on the economic use of water and conservation. The Policy also guides the reduction of water leakages from domestic water supplies as part of good practice in water resources management.

2.2 Water Supply and Sanitation Act, 2019

Section 20 (a) of the Act requires WSSAs to provide water supply and sanitation services for uses as required by the Act or any other written law dealing with the management of water resources, water quality standards and the environment. Further, Section 20(c) of the Act directs WSSAs to develop and maintain water and sanitation works. In this regard, the development of water supply systems that are

compliant with standards will enable efficient provision of water services including proper management of NRW.

2.3 Water Supply Regulations, 2019

According to Regulation 28(2) of the Water Supply Regulations (2019), WSSAs are required to ensure that consumers' service lines shall not at any time be in such defective condition or laid or fixed in such position in such manner as to cause damage, obstruction to any service or pollution of water supplied by the water authority. In addition, Regulation 37 emphasises that a pipe for the conveyance of or in connection with water supplied by the water authority shall not be connected with any pipe, cistern, butt or other receptacle used or capable of being used for the conveyance or reception of any water other than water supplied by the water authority. Furthermore, the Regulations directs on the adequate depth of pipes and management of water meters (including fixing, testing, maintenance and repair of meters). Implementation of these provisions of the Regulations has a direct impact on the management of NRW.

2.4 Water Supply and Sanitation Services (Licensing and Quality of Service) Rules 2020

Rules 39 – 50 of the Water Supply and Sanitation Services (Licensing and Quality of Service) Rules 2020, provide directives and procedures to WSSAs on repair, maintenance and replacement of customer service lines; management of water meters; and processing of water bills. Further, the second schedule of the Rules provides the quality of service targets to be attained by WSSAs with regard to meter reading and repair or replacement of water meters. These provisions are in line with the management of NRW in WSSAs service areas.

3. ASSESSMENT OF THE UTILITY NRW SITUATION

For a WSSA to develop an NRW reduction strategy, it must conduct self-assessments of its current situation and identify problems and key areas for interventions in reducing NRW. By conducting self-assessment, a WSSA will be able to identify areas of weakness and strength in reducing NRW in all aspects of NRW management, including technical, commercial, financial and management practices. Generally, there are various tools that a water utility can use to assess the current situation in NRW management, such as problem tree analysis, water audit/water balance and self-assessment matrix. In these Guidelines, a self-assessment matrix and a water balance computational tool have been adopted and will be used by WSSAs to conduct a self-assessment and water audit. These tools were selected by considering best practices in NRW management and applicability in the operating environment of WSSAs. The two tools will enable WSSAs to establish the current amount of water losses for each component of NRW and assess the technical and managerial capacity of the WSSA to manage NRW.

3.1 Self-Assessment Matrix

The Self-Assessment Matrix tool developed by World Bank through the Manager's Non-Revenue Water Handbook for Africa in 2010 is recognised as the best approach that can be used by water utilities in identifying technical, commercial, financial and management practices that influence NRW Management. In this approach, WSSAs are required to conduct self-assessment by completing the Self-Assessment Matrix shown in Table 1. By filling in the self-assessment matrix, a WSSA can assess its

current situation and practices in managing NRW against the best practices in water balancing, flow and pressure monitoring, mapping of the network, leak repair records, NRW performance indicators, active leakage control and customer metering.

Each area to be assessed is divided into five (5) levels, according to which each WSSA must assess its own position. Level 1 is the most basic and corresponds to the situation where operations in relation to that area are still poor therefore need improvement. Level 5 is the most advanced and recommended best practice where nearly all possible NRW measures have been taken, and the utility is at a highly advanced stage in NRW Management. All WSSAs can easily assess their status based on this self-assessment matrix. Once this is done, the steps for WSSAs to follow to improve NRW management commence with listing all key issues as identified in the matrix that requires interventions. A sample of a filled self-assessment matrix is attached as Appendix 1 of these Guidelines to demonstrate the proper application of the self-assessment matrix. As shown in the referred appendix, for each issue/ area, a WSSA will assess itself and highlight the most relevant level attained based on information/description that has been provided.

Table 1: Self-Assessment Matrix to be Filled by WSSA

	Issues / Level	1 Basic	2	3	4	5 High
1	**Water Balance, Flow and Pressure Monitoring, Mapping**					
1.1	Water Balance					
1.2	System Input Metering					
1.3	Pressure Monitoring					
1.4	Maps/GIS					
2	**Leak Repair Records**					
2.1	Leak Repair Records					
3	**Performance Indicators**					
3.1	Performance Indicators					
4	**Active leakage control**					
4.1	Active leakage control					
4.2	District Meter Areas (DMAs)					
4.3	Leak Repair - Distribution Pipes (Repair Time)					
4.4	Leak Repair - House Connections					
5	**Customer Metering**					
5.1	Customer Metering					
5.2	Customer Meter Replacement and Age					
5.3	Customer Meter Class					
5.4	Customer Database					
5.5	Customer Meter Reading					
5.6	Illegal Connections, meter tampering, bypasses					

	Issues / Level	1 Basic	2	3	4	5 High
6	**Institutional Performance**					
6.1	NRW Team/Section					
6.2	Capacity Building					
6.3	Database and Procedure for NRW Management					
7	**Stakeholders Involvement**					

Source: World Bank Institute (2010)

3.2 Establishing a Water Balance

After the WSSA has conducted self-assessment, it is required to conduct a water balance to quantify and understand how much water is lost, where and why is it lost and recommend realistic actions to reduce NRW. A water balance will help WSSAs to answer three typical questions, which are:

(i) How much water is being lost?
(ii) Where is it being lost?
(iii) Why is it being lost?

The IWA Water Balance Methodology has been accepted internationally as best practice and is the most widely applied method by most water utilities for conducting water balance. The method defines NRW as the difference between system input volume and revenue water. It is comprised of water losses and unbilled authorised consumption (water for flushing mains, firefighting, flushing of sewer lines etc.). Water loss is made up of two components: real losses and apparent losses. Real losses refer to the annual volumes lost through all types of leaks and breaks on mains, service reservoirs (including overflows) and service connections, up to the point of customer metering. Apparent losses are the non-physical losses that include customer meter under-registration, unauthorised use, meter reading and data handling errors. The IWA standard water balance is presented in Figure 1.

<table>
<tr><td rowspan="8">System Input Volume (allow for known errors)</td><td rowspan="2">Authorised consumption</td><td rowspan="2">Billed Authorized consumption</td><td>Billed Metered Consumption</td><td rowspan="2">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorized consumption</td><td>Unbilled Metered Consumption</td><td rowspan="6">Non- Revenue Water (NRW)</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="4">Water losses</td><td rowspan="2">Commercial losses</td><td>Unauthorized Consumption</td></tr>
<tr><td>Customer Metering Inaccuracies and Data Handling Errors</td></tr>
<tr><td rowspan="3">Physical Losses</td><td>Leakage on Transmission and/or Distribution Mains</td></tr>
<tr><td>Leakage and Overflows at Utility's Storage Tanks</td></tr>
<tr><td>Leakage on Service Connections up to Point of Customer Use</td></tr>
</table>

Figure 1: Water Balance showing NRW Components

The steps to establish the water balance and its components are detailed in the following sections.

3.3 Steps in Establishing the Water Balance

WSSAs shall establish all water balance components on a monthly basis and express them in volumetric terms. The quantification can be easier if the utility water supply system is metered, but it is also possible to establish reasonably accurate water balances in systems with largely unmetered consumption. There are five basic steps recommended for establishing the water balance.

Step 1: Determining System Input Volume

If the entire system input of the WSSA is metered, the system input volume should be determined from the record of water measured at the water meter. System input volume may comprise of water produced by the utility and amount imported from a bulk supplier. If there are some unmetered sources in the WSSA, the system input volume can be estimated using, for example, temporary flow measurements from portable devices (ultrasonic flow meter), reservoir drop tests (by observing dropping in water level from a reservoir of known volume) or average pumping hours.

Step 2: Determining Authorized Consumption

Authorised consumption consists of four components: billed metered consumption, billed unmetered consumption, unbilled metered consumption, and unbilled unmetered consumption.

(i) Billed Metered Consumption

Billed metered consumption of the different consumer categories will be extracted from the utility's billing system and analysed. The analysis of billed metered consumption should consider possible billing and data handling errors to ensure proper estimation of apparent losses. The general accuracy of the various makes and models of domestic and non-domestic consumption meters shall also be determined using a 95% confidence limit analysis.

(ii) Billed Unmetered Consumption

WSSA should obtain a billed unmetered estimate of water consumption from the billing system. In order to validate the accuracy of the estimates, a sample of unmetered domestic customers should be identified and monitored for three months consecutively, either by the installation of meters on those non-metered connections or by measuring a small area with a number of unmetered customers. For non-domestic customers that are unmetered, detailed surveys have to be carried out to check the accuracy of the estimated billed consumption figures.

(iii) Unbilled Metered Consumption

The volume of unbilled metered consumption has to be established similar to that of billed metered consumption.

(iv) Unbilled Unmetered Consumption

Unbilled unmetered consumption includes water used by the WSSA for operational purposes. Components of unbilled unmetered consumption shall be identified and individually estimated. For example:

- Water mains/sewer flushing: how many times per month? For how long? How much water was used?
- Firefighting: has there been any fire incident? How much water was used?

Step 3: Estimating Apparent Losses

Apparent water losses consist of three components, namely unauthorised consumption, customer meter inaccuracies and data handling errors as described below.

(i) Unauthorised Consumption

Unauthorised consumption can include illegal connections, misuse of fire hydrants and firefighting systems, vandalised or bypassed consumption meters and unethical practices of meter readers. WSSAs should establish a proper means of estimating unauthorised consumption based on the knowledge of the local WSSA's situation.

(ii) Customer meter inaccuracies

Customer meter inaccuracies could be under-or-over registration and have to be established based on tests of a representative sample of meters. The composition of the sample shall reflect the various brands and age groups of customer meters. The tests are to be conducted by the Weights and Measures Agency in accordance with relevant standards and procedures. Based on the results of the accuracy tests, average meter inaccuracy values (as % of metered consumption) will be established for different user groups.

(iii) Data Handling Errors

Data handling errors occur during data capture, data transmission, data processing and meter reading procedures and may be a substantial component of apparent losses. Many billing systems are not up to the expectations of the utilities, but problems often remain unrecognised for years. It is possible to detect data handling errors and problems with the billing system by exporting billing data and analysing it using standard database software. The detected problems have to be quantified, and the best estimate of the annual volume of this component has to be calculated.

Step 4: Calculating Real/physical Losses

The volume of real losses is the difference between the system input and all consumption elements; water exported; and apparent losses. Real/ physical water losses comprise leakage from any part of the water distribution system. These include leakage on transmission and distribution mains, leakage from floors and walls of tanks and overflows from storage tanks, leakage on service connections up to the customer meter, and leakage from joints and fittings. These losses are mainly caused by poor operation and maintenance of the water supply system, lack of active leakage control and poor quality of underground assets.

Step 5: Estimating Real Loss Components

To accurately split real losses into its components will only be possible with a detailed component analysis. However, the first estimate can be made using a few basic estimates.

(i) Leakage on Transmission and/or Distribution Mains

Bursts on distribution and especially transmission mains are primarily large events. They are visible, reported and can quickly be repaired. By using data from the repair records, the number of leaks on mains repaired during the reporting period can be calculated and an average flow rate estimated. Hence, the total volume of leakage from mains can be calculated as follows:

Volume of leakages = number of reported bursts x average leak flow rate x average leak duration

(ii) Leakage and Overflows at WSSA's Storage Tanks

Leakage and overflows at storage tanks are usually known and can be quantified. Overflows can be observed and the average duration and flow rate of the events estimated. Leakage of storage tanks can be calculated by making a water level drop test within the tanks when outflow valves are closed.

(iii) Leakage on Service Connections up to Point of Customer Metering

By deducting mains leakage and storage tank leakage from the total volume of real losses, the approximate quantity of service connection leakage can be calculated. This leakage volume includes reported and repaired service connection leaks and hidden leaks and background losses from service connections.

After the WSSA has quantified water losses for each component of NRW, they will be able to assess the water balance and establish key priority areas to address. A sample of Water Balance attached as Appendix 2 of these Guidelines can be used to guide WSSAs in the computation of water balance. WSSAs are also advised to use *EasyCalc* - an Excel spreadsheet computational tool that was developed by the World Bank and can be accessed freely on the internet to quantify their water losses.

3.4 Identification of Key Strategic Areas Potential for Reduction of NRW

The output from the self-assessment matrix and water balance will enable WSSAs to prepare a list of intervention areas and actions required for improving NRW to be summarised as indicated in Table 2. The level column in the table should be filled with a numerical number to be derived from the self-assessment matrix table. Thereafter, indicate a strategy to intervene in the identified issues under the column of strategy areas and mention actions needed for each strategy. Examples of intervention areas and actions required for NRW reduction are shown in Appendix 3.

Table 2: Strategies for Reduction of NRW

S/N	Issue from Self-Assessment Matrix	Self-Assessment Level	Strategy (Intervention Area)	Action Required
	Physical Losses (Real Losses)			
1.1	System Input Metering (bulk metering)	*1*	*Bulk metering*	*Install bulk water meter at all water production points*
1.2	Pressure Monitoring			
1.3	Maps/GIS			
1.4	Leak Repair Records			
1.5	Active leakage control			
1.6	Leak Repair - Distribution Pipes (Repair Time)			
1.7	Leak Repair - House Connections			

S/N	Issue from Self-Assessment Matrix	Self-Assessment Level	Strategy (Intervention Area)	Action Required
1.8	District Meter Areas (DMAs			
2	**Apparent (Commercial) Losses**			
2.1	Customer Metering			
2.2	Customer Meter Replacement and Age			
2.3	Customer Meter Class			
2.4	Customer Database			
2.5	Customer Meter Reading			
2.6	Illegal Connections			
2.7	Meter tampering			
2.8	Meter bypasses			
3	**Unbilled authorised Consumption**			
3.1	Firefighting			
3.2	Flushing of sewer lines			
3.4	Water provider for free for consumer group			
3.5	Water for cleaning of water storage tanks			
3.6	Water for flushing of water supply system			
4	**Performance Indicators**			
4.1	Performance Indicators			
5	**NRW Computational Tool**			
5.1	Water Balance			
6	**Institutional Performance**			
6.1	NRW Team/section			
6.2	Capacity building			
6.3	Database and Procedure for NRW management			
7	**Stakeholders Involvement**			

4. DEVELOPING NRW REDUCTION STRATEGY AND IMPLEMENTATION PLAN

NRW reduction strategy provides actionable strategic measures that focus on the key strategies/intervention areas potential for reducing NRW.

4.1 Developing NRW Reduction Mechanisms

WSSAs should understand and identify the major components of NRW and develop a strategy to reduce the targeted components. For each targeted component, WSSAs are required to develop a mechanism that includes approaches and procedures to

minimise/reduce the level of NRW in the water supply system. Based on the targeted components of NRW in Table 3, WSSAs are required to develop the management approaches that will ensure the development of action plans, targets, priority areas, and budgets.

The WSSAs should conduct self-assessment to establish appropriate management approaches as guided in Appendix 1. The management approaches could be through the establishment of NRW Team, established NRW Section or engagement of private sector. NRW Team should comprise members from each operational department/ unit, including technical, commercial, finance, procurement, legal, human resource and customer care/public relations. The reporting mechanism of the NRW Team will be determined by the WSSA's Management. Table 3 summarises the description of management approaches for the reduction of NRW.

Further, for sustainable implementation of NRW reduction strategy, WSSAs should have a strategy for involving internal and external stakeholders in the activities for NRW reduction. The involvement of stakeholders may be implemented through awareness campaign programmes.

Table 3: Management Approaches of Reduction of NRW

Approach/Model	Description	Remarks
NRW Team	A Team within a WSSA dedicated to NRW reduction activities	Can be applied to any WSSAs
NRW Section	This is a section in the WSSA organisation structure that has a major role in handling NRW activities on a daily basis	Mostly applicable for WSSAs with a big/large customer base (more than 50,000 customers or producing more than 80,000m^3/day).
Private Sector Participation (PSP)	Engage the private sector operator responsible for the reduction of NRW activities. It involves a contract between WSSAs and private operator including contractor / NGOs / CBOs	All WSSAs can adopt private sector participation. However, WSSAs need to conduct self-assessment

4.2 Setting NRW Reduction Targets

WSSAs should set the desired output/results expected after implementing the key strategies and NRW reduction mechanism. A WSSA needs to establish the base targets that will be used to monitor the performance against set new targets in the reduction of NRW for key strategic areas. The set targets to be achieved shall be in line with the WSSA's vision and planning for a specific duration so that follow-up and evaluation on the implementation could be conducted. A WSSA should identify short term (within three (3) years, medium-term (within five (5) years) and long term (longer than five (5) years) targets to be attained. The short-term targets will be in line with the WSSA's business plan and customer service charter, and medium-term targets to align with a strategic plan, and long-term plans to be in line with the WSSA's long term plan. The set targets will be in two levels:

(i) Broad targets for key performance indicators which reflect the impact of the implementation of activities included in the action plan

The format for presentation of these broad targets is shown in table 4.

Table 4: WSSA's Broad Targets for NRW Performance Indicator

NRW-Indicator	Baseline	Short Term Targets (3yrs			Medium-Term Target (5yrs)		Long Term Targets (10yrs)
		Y1 (FY)	Y2 (FY)	Y3 (FY)	Y4 (FY)	Y5 (FY)	Y6 to Y10 (FY)
NRW as percentage of water produced (%)	*45*	*40*	*33*	*25*	*23*	*21*	*15*
NRW expressed as real water losses per connection per day (m3/conn/day)							
NRW expressed as apparent water losses per connection per day (m3/conn/day)							
NRW expressed as real water losses per length of water mains (m3/km/day)							
NRW expressed as apparent water losses per length of water mains (m^3/km/day)							

NB: Water produced means the system input volume which may comprise of water supplied by a Utility from own water sources and amount imported from a bulk supplier (if any).

(ii) Targets are set for each strategy to be implemented to address NRW reduction

WSSAs should prioritise strategic areas based on self-assessment results, the desired impact of the strategy with reference to IWA standard water balance in reducing NRW, and resources that will be required. By using the IWA water balance, a WSSA would have identified areas with high water losses; hence addressing those areas will have a high impact on NRW. Resources that will be required means the costs associated with implementing the strategy as detailed in Table 5. For example, high priority may be allocated to quick win activities (actions that will significantly impact the reduction of NRW but with relatively lower costs). Prioritisation will be done by ranking the actions from the first to the last in order of priority.

Table 5: WSSA's Targets for Strategic Issue for NRW Reduction

S/N	Area of Intervention (Strategy)	Action Required	Baseline	Target description	Targets to be achieved			Priority
					Y1	Y2	Y3	
1	*Bulk metering*	*Meter all water production points*	*One (1) out of eight (8) production point is metered*	*Seven (7) water production points to be metered*	*2*	*3*	*2*	

4.3 Developing Action Plan and Budget

Based on the prioritisation of implementation of key strategic areas for reduction of NRW, WSSA should prepare the action plan and budget. The action plan shall consist of activity, target to be achieved, time and responsibility. The action plan for the NRW reduction strategy should be kept as an annex to the Business Plan adopting the format shown in Table 6.

Table 6: Action Plan for NRW Reduction Strategy

Priority	Area of Intervention (Strategy)	Action Required	Baseline	Target description	Targets to be achieved			Budget (TZS)			Indicator	Responsible
					Y1	Y2	Y3	Y1	Y2	Y3		
1	*Bulk metering*	*Meter all water production points*	*One (1) out of eight (8) production points is metered*	*Seven (7) water production points to be metered*	*2*	*3*	*2*	*xx*	*xx*	*xx*	*Number of metered points*	*TM*

5. MONITORING AND EVALUATION

WSSAs shall establish a mechanism for monitoring the implementation of NRW reduction strategy. WSSAs shall also evaluate the impact on the reduction of NRW following the rollout of the strategy. To monitor and evaluate the strategy, a WSSA should design a reporting system which will include, among other things:

(i) Collect periodic information/data to monitor the progress of implementation of the NRW reduction action plan;
(ii) Analyse collected information/data;
(iii) Evaluate the impact of the intervention on NRW based on IWA water balance; and
(iv) NRW performance indicators.

The implementation status of the strategy shall be included in the Annual Reports of WSSAs, which should be submitted to EWURA after approval by the WSSA's Board. Based on the Annual Reports of WSSAs, EWURA will monitor the WSSAs on the implementation of NRW reduction strategy through inspections.

WSSAs should monitor the implementation of the strategy monthly and submit a progress report to the WSSA's Board quarterly. Implementation of the Strategy will be deliberated by the Board of the respective WSSA or its appropriate Board Committee as the board may determine. Further, WSSAs should conduct water audits and adopt IWA water balance model to determine the components of NRW on monthly basis. Apart from the monthly water audit, WSSAs shall conduct a comprehensive annual water audit as prescribed by Rule 18 of the Water Supply and Sanitation Services (Licensing and Quality of Service) Rules, 2020. Furthermore, WSSAs should monitor and report the following key performance indicators for NRW:

(i) NRW as a percentage of water produced (%);
(ii) NRW expressed as total water losses (real/apparent) per connections per day (m3/conn/day); and
(iii) NRW expressed as total water losses (real/apparent) per length of water mains (m^3/km/day).

In addition to the above indicators, WSSAs with pressure management systems may consider the adoption of the Infrastructure Leakage Index (ILI) to monitor the performance of NRW as recommended by IWA.

6. PRESENTATION OF THE NRW REDUCTION STRATEGY

Presentation of the NRW Reduction Strategy will, as a minimum, follow the contents outlined in Appendix 4 of these Guidelines. The NRW Reduction Strategy will be reviewed after every three years in line with the WSSA's business plan.

APPENDICES

Appendix 1: Self Assessment Matrix Tool

S/N	Level / Issues / questions	1 Basic	2	3	4	5 High
1.1	**Water Balance**	We do not establish a water balance	We have tried to establish a water balance but gave up since we don't know the split in physical and commercial losses	We establish a water balance following our own format	We establish an annual water balance in accordance with the international form	We establish an annual water balance according to the international form and use 95% confidence limits to indicate accuracy bands.
1.2	**System Input Metering (own Production and imported water)**	Most of our system input is not metered	Not all, but >50% of our system input is metered	Our system input is metered, but we are not sure about the accuracy of these (partly old) meters	Our system input is metered with mechanical and/ or magnetic flow meters that are rarely calibrated	Our system input is metered with magnetic flow meters that are regularly calibrated
1.3	**Pressure Monitoring**	We do not have any pressure recorders installed	We have a few pressure recorders at pumping stations and treatment installed	We have a few pressure recorders at pumping stations and treatment plants and sporadically measure pressure in the distribution network with pressure loggers	We have a few pressure recorders at pumping stations and treatment plants and sporadically measure pressure in the distribution network with pressure gauges	We have permanently installed pressure loggers and continuously monitor pressure in the distribution network
1.4	**Maps/GIS**	We do not have maps at all	The maps we have are not updated	We have started to update our maps	Our maps are updated but do not include GIS	We use GIS based on updated maps

S/N	Level / Issues / questions	1 Basic	2	3	4	5 High
2 Leak Repair Records						
2.1	**Leak Repair Records**	We have no records of leak repairs	The only way to know the number of leaks repaired is to look into the customer complaints book	We keep basic leak repair records that only tell us whether the leak was on the main pipe or a service connection	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date and duration of repair	We keep detailed records that indicate location, pipe diameter, material and type of leak as well date of detection and date of repair and have linked this to our GIS
3 Performance Indicators						
3.1	**Performance Indicators**	The only PI used is 1% NRW	We have tried to calculate water loss performance indicators	We regularly calculate physical loss performance indicators	We regularly calculate physical and commercial loss performance indicators	We regularly calculate physical and commercial loss performance indicators and publish them in our annual report
4 Active Leakage Control						
4.1	**Active leakage control**	We only repair visible leaks	We have leak detection equipment, but we do not use it.	We do leak detection occasionally if there is a specific problem in an area.	We have started to do regular leak surveys	We cover the network by leakage survey at least once a year
4.2	**District Meter Areas (DMAs)**	We have no DMAs and have no plans to establish DMAs	We have started to establish the first DMAs	The first DMAs are established, and we have already the first results	We have several DMAs and check and analyse inflow data sporadically	We have several DMAs and monitor flow and pressure on a regular basis
4.3	**Leak Repair - Distribution Pipes (Repair Time)**	We have no records and therefore don't know how fast our leaks repaired	Our average repair time is more than 7 days	Our average repair time is between 7 and 3 days	Our average repair time is between 3 and 1.5 days	Our average repair time is less than 1.5 days

S/N	Level / Issues / questions	1 Basic	2	3	4	5 High
4.4	**Leak Repair - House Connections**	We have no records and therefore don't know how fast our leaks repaired	Our average repair time is more than 14 days	Our average repair time is between 14 and 7 days	Our average repair time is between 7 and 2 days	Our average repair time is less than 2 days
5 Customer Metering						
5.1	**Customer Metering**	We have no customer metering	Only large customers are metered	We have started with universal customer meters, but at present, not all customers have meters installed	Nearly all of our customers are metered, exceptpublic fountain, stand-pipes, fire hydrants, water drawing points for flushing of sewer lines, water provided to free consumers and similar	100% of our customers are metered
5.2	**Customer Meter Replacement and Age**	We have no reliable information on the age of our customer meters	Many of our customer meters are older than 10 years, and we have not yet introduced a regular replacement policy	We only change meters if they are obviously not functioning anymore	We have a meter replacement policy but have not been able to change all meters, so some of our customer meters are still older than 10 years	We strictly follow our customer meter replacement policy and replace all meters every 5 - 7 years
5.3	**Customer Meter Class**	All customer meters are Class B	All customer meters are Class B and C	All customer meters are Class C	All customer meters are Class C and D	All customer meters are Class D
5.4	**Customer Database**	Our customer database has not been updated for a long time	We sporadically update our customer database	we are in the process of updating our customer database	We regularly update our customer database by the house to house surveys and checks	We have an updated customer database that is linked to the GIS

S/N	Level / Issues / questions	1 Basic	2	3	4	5 High
5.5	**Customer Meter Reading**	We have no special system of controlling meter readers	We sporadically rotate meter readers if we are suspicious of inaccuracies	We regularly rotate meter readers	We regularly rotate meter readers and make often spot checks	Our meter readers use handheld meter reading devices
5.6	**Illegal Connections, meter tampering, bypasses**	We have not made any assessment and have no program to deal with water theft	We occasionally detect illegal connections	We occasionally detect illegal connections and other forms of fraud	We have a thorough illegal connection detection program	We have a thorough illegal connection detection program and also try to identify bypasses
6.	**Institutional Performance**					
6.1	NRW Team/section	We have no NRW Team	We have an idea of an NRW Team, but we never establish	We have an NRW Team which never operate	We have an NRW Team that operate on an ad-hoc basis	We have an NRW Team that is fully operational and involves staff from all departments/units
6.2	Capacity building	We do not have a capacity-building programme	We have an idea of a capacity-building programme, but we never developed	We have a capacity-building programme which is inadequately implemented	We have a capacity-building programme including only training and awareness programmes which is not fully implemented	We have a capacity-building programme including training and awareness programmes and equipment/facilities which is fully implemented
6.3	Database and Procedure for NRW management	We have no database and documented procedures for NRW management	We have an idea for a database and procedures for NRW management.	We have a database with little information and procedure NRW management	We have a complete database and procedures for NRW management.	We have a complete database with updated information and operational procedures for NRW management
7	**Stakeholders Involvement**	We do not involve stakeholders in NRW reduction activities	We have ideas to develop plans to involve stakeholders	We have plans to involve stakeholders, but we never implemented them	We are implementing plans that involve a limited number of key stakeholders in NRW reduction activities	We are implementing plans that involve all key stakeholders in NRW reduction activities.

Appendix 2: Sample WSSA IWA Standard Water Balance Tool

Water Sources	Volume (m3/Year	Component description	Volume (m3/Year	Component description	Volume (m3/Year	Component description	Volume (m3/Year	Component description	Volume (m3/Year	Component description	Volume (m3/Year	Component description		Volume (m3/Year
Owns Sources	5,201,761	System Inputs	4,668,691.00	Water Exported	0							Billed Water Exported	to be extracted from billing system	0
				Water Supplied	4,668,691	Authorised Consumption	3,552,432.74	Billed Authorised Consumption	3,530,470.84	Revenue Water	3,530,470.84	Billed Metered Consumption	to be extracted from billing system (domestic, industrial, commercial, institution,kiosk)	2,872,871.71
														456,704.50
														132,893.74
														26,163.82
														41,837.07
												Billed Unmetered Consumption	average consumption per household multiply by total number of unmetered household	0.00
													summation of indivdual estimated consumption for non domestic	0.00
								Unbilled Authorised Consumption	21,961.90	Non- Revenue Water	1,138,220.15	Unbilled Metered Consumption	to be extracted from billing system	728.73
												Unbilled Unmetered Consumption	summation of indivdual estimated consumption	21,233.17
						Water Losses	1,116,258.25	Apparent Losses	737,094.44			Unauthorised Consumption	Total System Iput - Billed - Sum of all losses	62,941.19
												Customer Metering Inaccuracies	estimate base on the average meter accuarcy by considering brand, age, usage: results over meter accuracy can be obtained from accuracy test	674,153.25
Water Imported	0							Real Loss	379,163.81			Leakage on Mains	number of reported bursts x average leak flow rate x average leak duration	238,873.20
												Leakage and Overflows at Storages	=average durationx flow rate x number of the events	0.00
													making a water level drop test with in and outflow valves closed	11,374.91
												Leakages on service connections up to point of customers metering	number of reported leaks x average leak flow rate x average leak duration	128,915.70

Appendix 3: Example of Intervention Activities for NRW Reduction

S/N	Intervention Area	Action
1	Bulk metering	■ Installation of bulk water meters at water source ■ Installation of bulk water meters at the pumping station ■ Installation of bulk water meters at storage reservoir
2	Unmetered customers	Install water meters to all unmetered customers
3	Water Meter Management	■ Proper selection and installation of water meters ■ Establish and implement meter testing and replacement programme.
4	Customer database	■ Detailed customer survey ■ Update customer database and records ■ Procure and install billing software
5	Unauthorised use	■ Survey, checks and inspections to identify unauthorised use ■ Removal of unauthorised connections ■ Removal of meter tampering/bypasses ■ Awareness campaign against informality/unauthorised use ■ Relocation of water meters to the proper location ■ Sealing of water meters ■ Strengthen proactive programme to identify and curb illegal water use ■ Strengthening the existing legislation regarding illegal conduct
6	Malfunctioning customer meters	■ Inspection of all customer meters to identify non-functional ■ Replacement of malfunctioning customer meters
7	Customer billing database	■ Establishment of reporting procedures for unusual consumption ■ Review billing data for unusual consumption ■ Remedial action for unusual consumption cases
8	Billing errors	■ Improvement of meter reading and billing procedures ■ Use digital instruments for meter reading and reporting observations
9	Large customers	■ Review large customers' installations and meter sizing and type ■ Installation of smart meters to large customers
10	Mapping	■ Implement network records in a GIS environment ■ Update network records in a GIS environment
11	Leakage	■ Locate and fix visual leaks ■ Procure leaks detection equipment for identification of passive leakages by considering advanced technologies ■ Use of improved technology in pipes installation works ■ Proper handling of pipes and fittings before installation including having storage facilities ■ Ensure and maintain good workmanship ■ Pipe installation should adhere to Design, Construction, Supervision and Operational Manual ■ Procurement of quality materials (pipes and fittings) from reliable sources

S/N	Intervention Area	Action
12	District Metering Areas (DMA)	■ Establish DMA in the supply system ■ Maintain the existing DMAs ■ Install bulk water meters to DMAs ■ Conduct and analyse meter readings to all DMAs
13	Institutional Performance	■ Establish and maintain documented systems and procedures for NRW management ■ Create awareness on NRW reduction activities ■ Conduct capacity building in terms of skill development and equipment ■ Establish NRW team ■ Capacity building in terms of number of staff
14	Pressure management	■ Install pressure-reducing valves (PRV) ■ Construct break pressure tank (BPT) ■ Install pressure gauge at the water pumping and booster stations. ■ Schedule water production according to demand ■ Design the water supply system into hydraulic zones
15	Asset registration and management	■ Establish asset register ■ Maintain and update the existing asset register
16	Stakeholders Involvement	■ Create and implement public awareness programme on NRW reduction activities ■ Engage stakeholders in NRW reduction activities ■ Sensitise community to report NRW related incidents

Appendix 4: Contents of NRW Reduction Strategy

1. Executive Summary

2. Introduction

3. Description of the Water Utility

4. Assessment of the Utility NRW Water Situation

4.1. Self-Assessment Matrix
- *As per Table 1….*

4.2. Water Balance
- *Attach filled IWA water balance*
- *Discuss assumptions used to compute each component of the water balance*

4.3. Key Strategic Areas for Reduction of NRW
- *As per Table 2….*

5. NRW Reduction Strategy and Implementation Plan

5.1. NRW Reduction Mechanisms
- *Describe the management approaches that will be used (refer section 4.2)*

5.2. Setting NRW Reduction Targets
- *As per Table 4 & Table 5….*

5.3. Action plan and Budget
- *As per Table 6….*

6. Monitoring and Evaluation

6.1. Performance Indicator for Broad Targets
6.2. Performance Indicator for Activity Targets
6.3. Reporting
- *Describe the report that will be prepared*
- *Reporting frequency and format*
- *Reporting levels (EWURA, Board, Management etc)*

7. Annexes

Provide annexes as appropriate