THE UNITED REPUBLIC OF TANZANIA

NATIONAL AUDIT OFFICE

PERFORMANCE AUDIT REPORT ON THE MANAGEMENT OF WATER DISTRIBUTION IN URBAN AREAS

The Performance of the Ministry of Water, EWURA and Urban Water Supply and Sanitation Authorities in Controlling Water Losses

REPORT OF THE CONTROLLER AND
AUDITOR GENERAL OF
THE UNITED REPUBLIC OF TANZANIA
January, 2012

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PREFACE

The Public Audit Act No. 11 of 2008, Section 28 authorizes the Controller and Auditor General to carry out Performance Audit (Value-for-Money Audit) for the purposes of establishing the economy, efficiency and effectiveness of any expenditure or use of resources in the MDAs, LGAs and Public Authorities and other Bodies which involves enquiring, examining, investigating and reporting, as deemed necessary under the circumstances.

I have the honour to submit to His Excellency the President of the United Republic of Tanzania, Dr. Jakaya Mrisho Kikwete and through him to Parliament the Performance Audit Report on the Management of Water Distribution in Urban Areas. The report concerns the Performance of the Ministry of Water, EWURA and Urban Water Supply and Sanitation Authorities in Controlling Non – Revenue Water.

The report contains findings conclusions and recommendations that directly concern to UWSSAs, EWURA and the Ministry of Water (MOW). The said MDAs have been given the opportunity to scrutinise the factual content of and comment on the draft report. I wish to acknowledge that the discussions with the auditees, UWSSAs, EWURA and MOW have been very constructive.

My office intends to carry out a follow-up at an appropriate time regarding actions taken by the auditees in relation to the recommendations in this report.

On completion of the audit, the office subjected the report to Prof. Fredrick Mwanuzi, Dr. Magayane D. Machibya, Dr. Rubhera M. Mato and Eng. Ngwisa Mpembe who came up with useful inputs for improving the output of this report.

This audit report has been prepared by James G. Pilly, Warento Nyambabe, Asnath Mugasa, James Nyakia, Elizabeth Augustino and Michael Malabeja. I would like to thank my staff for their assistance in the preparation of this report. I would also like to extend my appreciations to the auditees for their fruitful interaction with my office.

Ludovick S.L. Utouh
Controller and Auditor General
Dar es Salaam
January 2012

ABBREVIATIONS

AFROSAI-E	African Organization of Supreme Audit Institution
CBOs	Community Based Organizations
COWSO	Community Owned water services Organisations
DAWASA	Dar es Salaam Water and Sanitation Authority
DAWASCO	Dar es Salaam Water and Sewarage Cooperation
EWURA	Energy and Water Utilities Regulatory Authority
HMIS	Harzoudous Material Identification System
INTOSAI	International Organizations of Supreme Audit Institutions
IWA	International Water Association
LAAC	Local Authorities Accounts Committee
LGAs	Local Government Authorities
MDAs	Ministries, Departments and Agencies
MOW	Ministry of Water
MTEF	Medium Term Expenditure Framework
NGOs	Non Government Organizations
NAO	National Audit Office
NRW	Non-Revenue Water
NWP	National Water Policy
O&M	Operations and Maintenance
PMO-RALG	Prime Minister's Office Regional Administration and Local Governments
TBS	Tanzania Bureau of Standards
TShs	Tanzania Shillings
UFW	Unaccounted For Water
UWSSA	Urban Water Supply and Sanitation Authority
VFM	Value For Money
WSSAs	Water Supply and Sewerage Authorities

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EXECUTIVE SUMMARY

Development of any society is reflected by among other things the availability of portable, clean and safe water. In Tanzania, quantity of water produced by most of the UWSSAs does not meet the demand. Thus, water availability for domestic use in the urban centres continues to be an important challenge when compared with quantity of water produced. In addition, water authorities also face the problem of water losses over years which further reduces part of demand from being met and in most of the urban areas there is intermittent water supply (some areas get supply once or twice a week whereas others do not get water for weeks).

Based on these problems, a performance audit on water distribution in urban areas was conducted to assess whether the UWSSAs management of urban water distribution adequately addresses the issue of water losses, commonly known as Non Revenue Water (NRW). The purpose of this audit was also to assess whether the monitoring activities carried out by central authorities – Energy and Water Utilities Regulatory Authority (EWURA) and the Ministry of Water (MoW) – are adequately addressing water losses.

Evidence gathering involved review of various documents of the period of three years from July 2007 to June 2011 and conducting interviews with MoW staff and other stakeholders in the water sector. Data on the management of water distribution has been collected from 8 selected UWSSAs out of the 20 UWSSAs across the country.

Main Findings

In spite of many strong indications that there is high levels of NRW in the UWSSAs, the UWSSAs, MoW and EWURA have not taken sufficient measures to quantify the losses and have not combated the problem of NRW in a proactive and systematic way. We found out that:-

i) For the three consecutive years covered in this audit there were no significant improvements in reduction of NRW trends for most of the audited UWSSAs. All UWSSAs had set the target of NRW below the MoW standard of 20%,

ii) Half of the UWSSAs covered in this audit have analyzed the causes of NRW and have documented strategies for reducing NRW but the strategies developed have no Action plan accompanied with the specific performance indicators that can be used to monitor the performance.

iii) UWSSAs have not conducted proactive inspections on the performance of their entire water distribution networks.

iv) The water leakages that occur after working hours, during week ends and public holidays are not recorded. The leak response time has not been recorded, in most incidences; it takes more than 24 hours to repair the reported leaks.

v) Although half of the audited UWSSAs have established toll free telephone lines to receive calls from customers on leaks, not all the lines have been working regularly.

vi) UWSSAs do not allocate separate budget as per MoU requirements for repair activities. Instead repair costs are combined with maintenance.

vii) There is no formal team which is used to ensure the quality of the materials received and used for field operations.

viii) Most of the UWSSAs audited lacked adequate water measuring facilities like bulk meters, customer meters and thus they failed to know exactly where, and how and why water is lost as it also makes the computation and management of NRW difficult.

ix) On average, UWSSAs are loosing revenues amounting to TShs 2.5 billion every month.

x) 3 out of 8 audited UWSSAs were found to have low customer metering efficiency (i.e. less than 100% metering) thus amount of water billed to customers is based on estimates which are subjective to errors and eventually commercial loss.

xi) The recommendations given by EWURA to UWSSA regarding the reduction of NRW have not been adequately implemented.

xii) EWURA seldom visited the UWSSAs with a view of validating the information regarding NRW that the UWSSAs submit to them. In addition, EWURA do not make follow ups geared at assessing the extent to which their recommendations have been implemented by UWSSAS.

Main Recommendations

Based on the findings, the National Audit Office is giving a number of recommendations aimed at addressing the identified deficiencies and weaknesses. The recommendations are based on:

Monitoring and Accounting for Water losses
The UWSSAs should ensure that they monitor levels of NRW with a view to minimize them to the set target of 20%.

This can be done by ensuring that:

i) A unit team is established with the sole purpose of dealing with issues of NRW management;

ii) Bulk Meters are installed at all points from production point to reservoir point and from reservoir to distribution points;

iii) All customers to be metered and the meters to be read every month in order to issue realistic bills that are based on metered consumption

Inspection of Water Networks
UWSSAs should ensure that:

i) They plan and conduct proactive inspections on the performance of their entire water distribution networks; and

ii) Should adequately support/empower the staff responsible for inspection through training and provision of necessary working tools and guidelines for their work

Repair of Water Networks

The UWSSAs should ensure that:

i) They properly record all reported/identified leakages and prepare plans to reduce the leakage response time to below 24 hours especially those incidences that occur after working hours, during the week ends and public holidays. This may be achieved by making a shift arrangement whereby a group of staff operate as a standby gang that will attend breakdowns at all times.

ii) They establish and maintain toll free telephone lines to receive calls from customers who report the leaks and make sure that all the lines are working at all times;

Maintenance of Water Networks

In order to reduce the amount of water lost through leaks, UWSSAs should ensure that maintenance and upkeep functions are given high priority throughout the utility. UWSSA should prepare a separate budget and implementation plans for preventive maintenance;

Monitoring of UWSSAs Performance

i) The Ministry of Water and EWURA should implement the requirements of the Water Supply and Sanitation Act of 2009 by adequately monitoring the activities of UWSSAs including the management of NRW.

ii) Likewise, EWURA should perform validation of the information regarding NRW that the UWSSAs submit to them. The Ministry of Water should make efforts to ensure that UWSSAs adequately control water losses.

CHAPTER ONE
INTRODUCTION

1.1 Background

Supply of clean, safe and good quality water is vital for any developing society. In Tanzania, water produced does not meet demand. Thus, water availability for domestic use in the urban centres continues to be an important challenge when compared with quantity of water produced. In addition, water authorities face the problem of water losses over years which reduces the chances of achieving their objective of meeting the demand of water.

Reasons for conducting this performance audit

Water supply in Tanzania is beset with many problems. Among these problems are low coverage, low service level, and intermittent water supply (some areas get supply once or twice a week whereas others do not get water for weeks). There are also frequent pipeline bursts (because of the pipelines being old, some laid as far back as 1940s) and leakages which also affect the quality of the water supplied. Table 1 below provides trends regarding the quantity of water produced, demand and NRW for the three consecutive years starting 2006/2007:

Table 1: Quantity of Water Produced vs. Demand for the UWSSAs

Fiscal Year	Quantity produced (millions cubic meters)		Demand (millions cubic meters)		Production as a percentage of Demand		Trend of NRW	
	DAWASCO	Other UWSSAs	DAWASCO	Other UWSSAs	DAWASCO	Other UWSSAs	DAWASCO	Other UWSSAs
2006/2007	86.9	98.83	149.7	138.34	58.1	71.5	55	39.6
2007/2008	92.7	104.05	164.3	144.84	56.5	71.9	57	37.0
2008/2009	95.2	110.93	164.3	154.55	58.0	71.8	54	36.2

Source: EWURA report, 2009 [1]

In Table 1 above it can be seen that the quantity of water produced by UWSSAs during the three successive years has not been enough to meet the demand.

During the fiscal year 2008/2009, the water losses for all the UWSSAs was more than 44% . This means close to a half of the water produced is lost before reaching the customer or is not billed. Water losses, whether because of leakage, theft, none or under billing of customers, or faulty controls of the system, represent human, social and monetary losses to the society.

Many water projects cost the government much money thus a need for proper accounting. Producing water and losing up to 50% is waste of taxpayer's money. In the developed world for instance Germany, NRW is set at a maximum of 5% only. In developing countries like Tanzania, the national maximum NRW limit is set to be 20%. Therefore the National Audit Office has decided to conduct a Performance Audit focused on managing water losses (commonly known as Nonrevenue Water (NRW)) in urban areas.

1 Water utility Performance Report for 2008/2009
2 This figure is obtained from auditors' calculations based reported production and NRW figures as provided EWURA in the 2008/09 report (Refer Appendix 2).

1.2 Audit Objective

The purpose of the audit was to assess whether the UWSSAs management of urban water distribution adequately addresses the issue of water losses. The purpose was also to assess whether the monitoring activities carried out by central authorities – Energy and Water Utilities Regulatory Authority (EWURA) and the Ministry of Water (MoW) – are adequately addressing water losses.

1.3 Audit Questions

The audit questions were focused on monitoring, inspection, repair, maintenance and proactive management by the UWSSAs, and on the regulatory roles of EWURA and MoW. Five questions concern activities carried out by the UWSSAs and one question concerns activities by the central authorities. The audit questions are as follows:

i. Do the urban water authorities have appropriate monitoring systems for water distribution in order to reduce water losses?
ii. Do the urban water authorities conduct adequate inspections?
iii. Do the urban water authorities efficiently address water leakages?
iv. Do the urban water authorities adequately maintain the distribution networks?
v. Do the urban water authorities take systematic actions to improve the efficiency of water distribution?
vi. Do the MoW and EWURA adequately monitor performance of the urban water authorities?

1.4 Audit Design

1.4.1 Audit Scope and Limitation

The audit covered an examination period of three years from July 2007 to June 2010. Data on the management of water distribution system has been collected from 8 selected UWSSAs out of 20 UWSSAs across the country. The selected eight UWSSAs were DAWASCO (Dar es Salaam), DUWASA (Dodoma), MUWASA (Mwanza), LUWASA (Lindi), MORUWASA (Morogoro), Tanga, MUWSA (Moshi) and KUWASA (Kigoma) because they have relatively higher water losses, or have very low water losses, or they added to the geographical diversity of our selections. EWURA and MOW were also covered because of their roles as regulators and policy makers respectively of the water supply sector.

1.4.2 Methods and implementation

Various methods were used in the collection of data and information for this audit. A review of various documents from the MoW and UWSSAs (including DAWASA and DAWASCO for Dar es Salaam) was done. This information was further corroborated with interviews with officials from different stakeholders (i.e. EWURA, selected UWSSAs and MoW). The following documents were reviewed:

i. Water Sector Policy;
ii. Operational Policies and Procedures (OPPs) and Standard Operating procedures;
iii. Water Resources Management Act No.11 of 2009;
iv. UWSSAs annual reports for 2007-2010, Annual report of EWURA on water distribution [3]
v. Interviews were conducted with a view to:

3. More documents can be found in the reference chapter

- Confirm or explain information from the documents reviewed;
- Give clues to relevant information in cases where information in the formal documents was lacking or missing; and
- Provide context and additional perspectives in relation to the documents reviewed.

vi. Interviews and discussions were carried out with:
- Various officers at DAWASCO Head Office and its operational areas as well as other officials from the Audited UWSSAs.
- Experts in the Water Sector Services;
- The users of the urban water distribution, Officials at MoW and EWURA.

In each UWSSA visited the team also conducted physical inspection to pipe networks

A Focus Group meeting was carried out in order to check and validate findings as well as preliminary conclusions and recommendations. The meeting was graced with participants from DAWASCO, MORUWASA, DUWASA, MUWASA and Tanga UWSSA. Representatives from the development partners like UNDP, World Bank, representatives from higher learning institutions like Ardhi University , University of Dar Es Salaam and Institute of water and development , NGOs and EWURA also participated in the meeting.

1.5 Data Validation Process

Inadequate record-keeping and controls of written documents made it necessary for the audit team to ascertain extent to rely on verbally provided information. This information was however, as much as possible, corroborated with information obtained through reviewing documents from regulatory authority (EWURA).

The audit team also consulted practicing scientists and other experts on the audit area to substantiate the information collected that was relevant, checked and supported. The MoW and the selected UWSSAs were given opportunity by the National Audit Office to go through the draft report. They confirmed the accuracy of the information presented.

1.6 Assessment criteria

As seen above, audit the questions were based on four key parameters. Starting from these parameters, the following assessment criteria have been used:

Monitoring system
- UWSSAs are supposed to ensure that, there is a continuous monitoring of water production in terms of quantity and quality (MoU [4]).
- UWSSAs are supposed to install water meters for the purpose of measuring the amount of water supplied to consumers (WSSA., Section-21(1c) [5])
- UWSSAs are supposed to report to EWURA monthly (report on water losses included) (MoU)
- Losses should not exceed 20% (MoU, EWURA)
- UWSSAs are supposed to prepare and timely submit monthly report before 14th of the following month to MoW and EWURA (MoU).

4. MOU refers to the Memorandum of Understanding between MOW and the UWSSAs for the period 2008 – 2011 (signed January 2009).
5. Water Supply and Sanitation Act of 2009.
6 National Water Policy of 2002

Inspections

– UWSSAs are supposed to carry out regular inspections, repairs and maintenance of the distribution system in order to contain water leakages.

Repair

– UWSSAs are expected to develop contingent plans and establish financing mechanism to deal with emergencies (NWP [6]) and have the ability to effectively carry out necessary repairs on the water distribution system.

Adequate Maintenance

– UWSSAs are supposed to carry out proper maintenance of water works connected to supply of water (MoU)
– UWSSA are supposed to develop preventive maintenance and management procedures to ensure that meters are calibrated at most every three years or whenever the need arises (MoU –Section. 8f)

Pro-active management

– UWSSAs are supposed to prepare annual budgets and submit them to MoW and EWURA.

1.7 Structure of the audit report

The other part of the report covers the following:

- Chapter two gives the account of the audit area with the water distribution system set up, procedures for monitoring, inspection, repair, maintenance and pro-active management of water distribution and water related activities and key actors.

- Chapter three presents the findings on water distribution monitoring, inspection, repair, maintenance and proactive management.

- Chapter four provides the conclusions and chapter five gives the recommendations which can be implemented in order to improve the situation.

CHAPTER TWO
WATER DISTRIBUTION – SYSTEM DESCRIPTION

2.1 The Urban Water Supply and Sanitation Authorities

Urban Water Supply and Sanitation Authorities (UWSSAs) have been established in accordance with the Waterworks Act No.8 (1997) in 19 major urban centres. In addition, Dar es Salaam Water and Sanitation Authority (DAWASA) was established under Waterworks Act No. 20 of 2001 to supply water to Dar es Salaam and parts of Pwani region, including Bagamoyo and Kibaha townships.
The authorities are graded under three categories:

- o Category A authorities cover all the O&M costs of water supply and sewerage, including staff wages, cost of power and some contributions to investment. In this category we selected water authorities of Mwanza, Dodoma, Tanga, Morogoro and Dar es Salaam
- o Category B authorities meet their O&M costs, including cost sharing of power (as per MoU with each authority) and full salaries for the permanent employees; In this category we selected water authorities of Kigoma
- o Category C authorities meet their O&M costs but require Government support in paying for power supply and the salaries of the permanent employees. In this category we selected water authorities of Lindi

2.2 Key Stakeholders in Water sector and their key Responsibilities

The stakeholders in the water sector are in several administrative sectors. The names and their responsibilities are as discussed in the following subsections:-

2.2.1 Central Government

i) The Ministry of Water

The institutional framework for the provision of water supply, sewerage and sanitation services is based on a separation of roles between urban water supply and sewerage services, and rural water supply services. The ultimate responsibility for the provision of these services rests largely with the Ministry responsible for Water.

The Ministry of Water (MoW) is responsible for developing policies and standards for water utilities. It is also responsible for the overall technical leadership, guidance and advice on the implementation and monitoring of the strategic plans.

ii) Energy and Water Utilities Regulatory Authority (EWURA)

The function of EWURA is to regulate Water Supply and Saniation Authorities(WSSAs) as per water supply and saniation Act,2009. EWURA is mandated to license and regulate commercialized Urban Water Supply and Sewerage Authorities (UWSSAs) and has developed performance indicators to measure financial and service delivery outcomes under the following responsibilities:

- Approves business plans of WSSAs.
- Issues operating licences to WSSAs.
- Establish standards related to equipment attached to the water and sanitation authorities
- Approves service tariffs.
- Publishes and issue technical guidelines and standards to UWSSA

iii) The Prime Minister's Office - Regional Administration and Local Government:

The Prime Minister's Office – Regional Administration and Local Government (PMO-RALG) co-ordinates planning by Local Government Authorities (LGAs) through the Regional Secretariats. This task includes planning of water projects from local government authorities, local government authority budgets, capacity building for local government authorities, monitoring of the use of funds and also administration of human resources at the regional and council levels.

District Level (Local Authorities)

Councils are represented on water resources management boards and committees to ensure the presence of an elected voice of the people during core decision making regarding water resources conservation, management, allocation development and utilization. Local Government Authorities are responsible for:

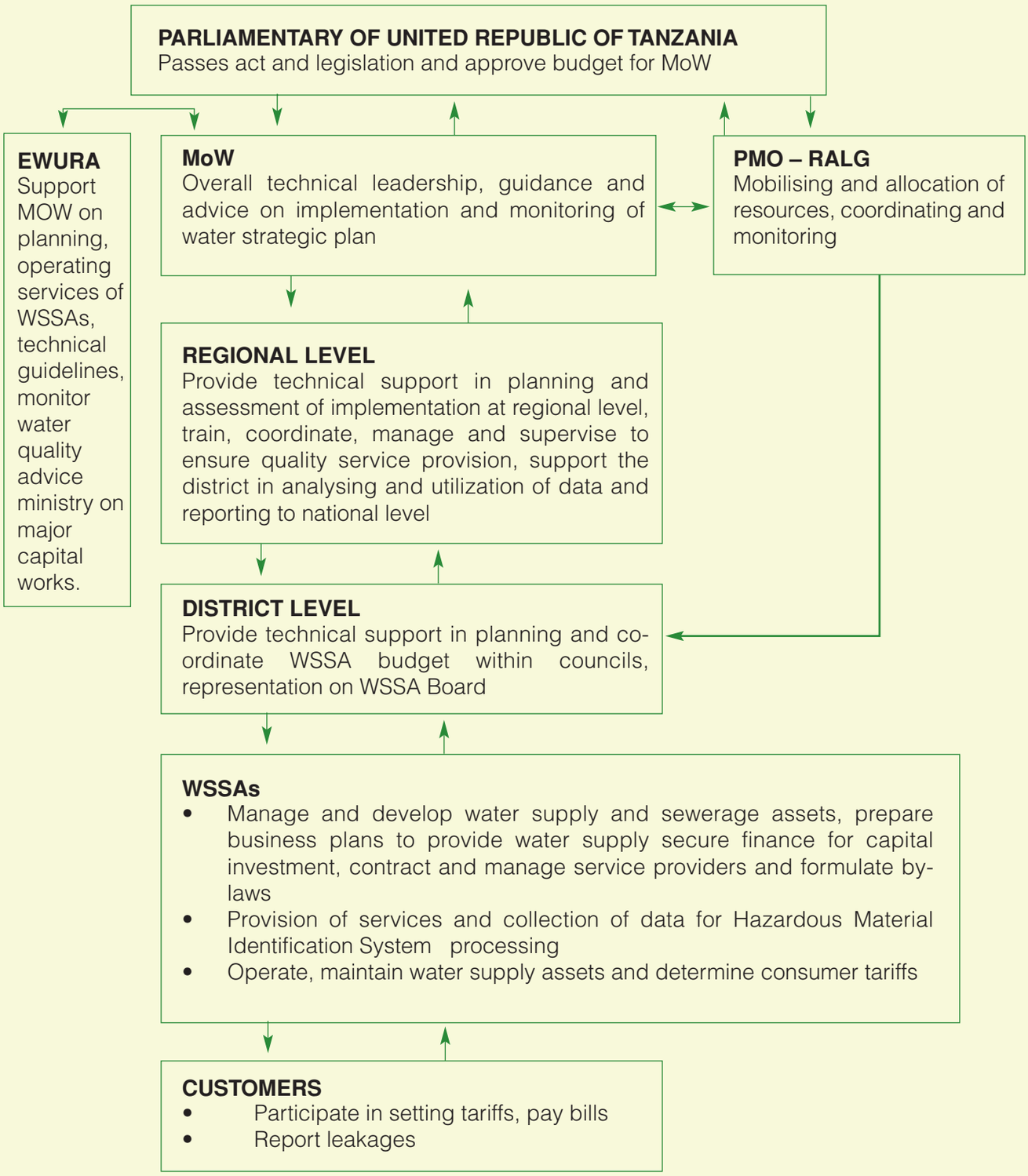
- Co-ordinate physical planning with WSSAs.
- Formulate by-laws concerning water supply and sanitation

2.2.2 Responsibilities of WSSAs

The responsibilities of Water Supply and Sanitation Authorities are:

i) To provide clean water supply services for various uses.
ii) To develop and maintain water works and sanitation works.
iii) To protect and maintain water sources.
iv) To install water meters for the purpose of measuring the amount of water supplied to the consumers.
v) To own, manage and develop water supply and sewerage assets.
vi) To prepare business plans according to EWURA business guidelines.
vii) To secure finance for capital investment, and relevant subsidies.

The figure below depicts the actors of water management in Tanzania.



Source: Ministry of Water

Figure1: Actors and their responsibilities in Urban Water Distribution

2.3 Monitoring Systems of Water Distribution Networks

The Memorandum of Understanding between UWSSAs and MoW requires the Water Authorities to have a continuous monitoring of water production in terms of quantity and quality (MoU [7]). Also, as per the Water Act, the Authorities are supposed to install water meters for the purpose of measuring the amount of water produced and supplied to the customers (Water Act 2009[8]). The MoU further requires:-

- UWSSA to monitor NRW that should not exceed 20% (MoW, EWURA)
- UWSSA to prepare and timely submit monthly reports before 14th of the following month to MoW and EWURA. And MoW is obliged to formulate policies, legislation and strategies pertaining to water supply and sewerage services and ensure dissemination at all levels
- MoW to monitor and evaluate the performance of the UWSSA's Board of Directors annually

Furthermore, in the lease agreement between DAWASA and DAWASCO, it was stated that DAWASA should install bulk meters in all areas of distribution and hand them over to DAWASCO to operate.

2.4 Inspection of Water Supply Networks

In order to reduce water losses through leakages, UWSSAs are expected to carry out regular inspection and maintenance of the distribution systems. Inspections can adequately be conducted if the inspectors are well supported and equipped to detect irregularities in the networks.

2.5 Planning and Funding of Water Leak Repair Activities

It is important at some stage of infrastructure management to decide whether it is more cost effective to replace mains or to continue with repairs.

UWSSAs' management are required to prepare annual budgets and plans which are supposed to be approved by the Boards of Directors. The budget so approved shall be submitted for information to MoW and EWURA by 30th of September for every year. The funds allocation is supposed to follow the following priorities: 1. Personal emoluments and statutory payments, 2. Utilities, 3. Operations, 4. Preventive maintenance, 5.Water user fees and EWURA Levy, 6.assets valuation both new and old as per International Financial Reporting Standards (IFRS), 7. Repairs and Replacement, 8. Development and investment [9].

Leak monitoring is done by the installation of flow meters at strategic points throughout the distribution networks, with each meter measuring the flow into a specific zone which has a well defined and permanent boundary. By this fact, UWSSAs are expected to develop contingent plans and establish financing mechanism to deal with emergencies (NWP [10])

7 MOU refers to the Memorandum of Understanding between MOW and the UWSSAs for the period 2008 – 2011 (signed January 2009).
8. Water Supply and Sanitation Act of 2009.
9 Memorandum of Understanding-January 2009
10 National Water Policy of 2002

2.6 Maintenance of the Water Supply Networks

Infrastructure management is one of the components of leakage reduction management strategies. The general condition of mains, service pipes, service reservoirs and other fittings of a water system is the most significant factor that affects the level of leakage in any water network. In view of that, UWSSAs' management are required to prepare annual budgets and plans which must incorporate a maintenance component. A complete maintenance plan includes the following components:

- Maintenance policy – Highest-level document, typically applies to the entire site.
- Maintenance strategy – Next level down, typically reviewed and updated every 1 to 2 years.
- Maintenance programme – Applies to an equipment system or work centre, describes the total package of all maintenance requirements to care for that system in order to keep in good condition and prevent leakages.
- Maintenance checklist – List of maintenance tasks (preventive or predictive) typically derived through some form of analysis.

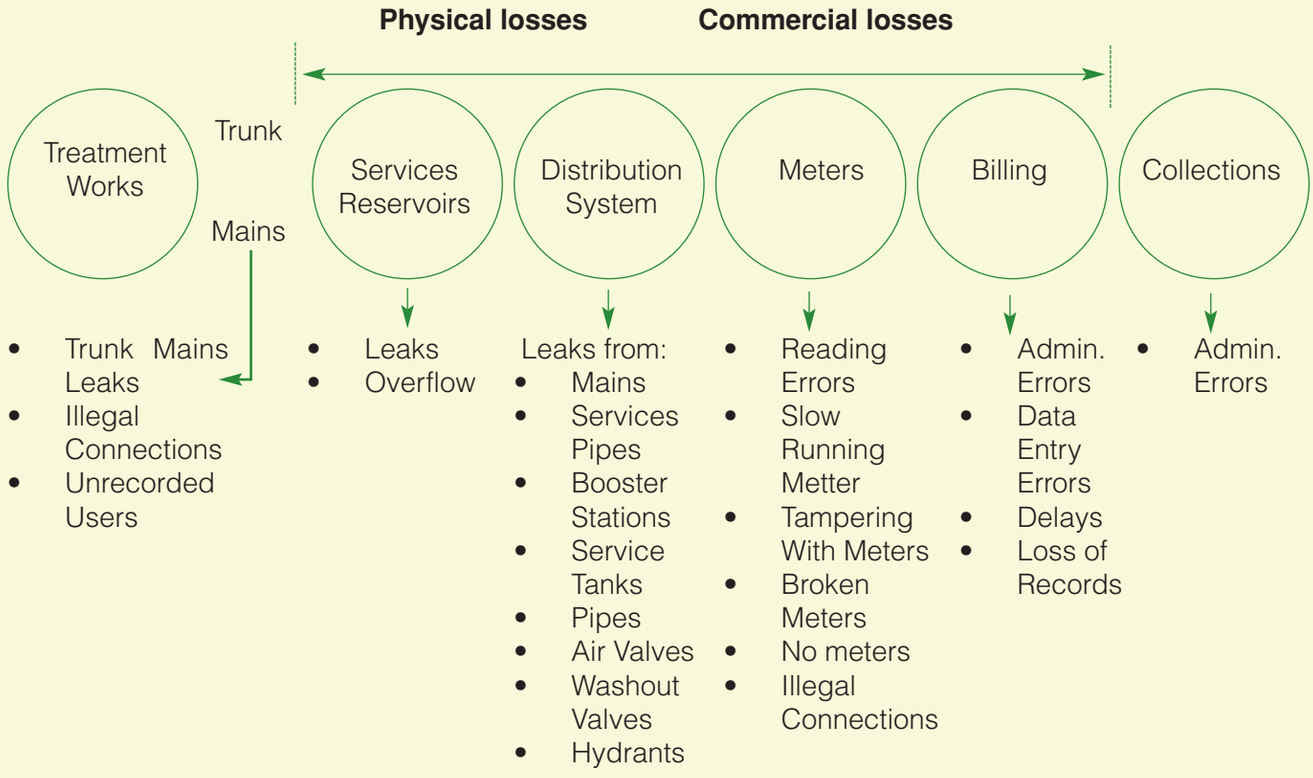
2.7 Actions of the Utility to Improve Efficiency of Water Distribution

Some activities regarding operations and maintenance undertaken by UWSSAs include water loss assessment, reduction strategies and activities emerging as the best practical approach to reduce water losses.

A water supply system typically includes:

1) A raw (untreated) water collection point: (above or below ground) where the water accumulates, such as a lake, a river, or groundwater from an underground aquifer. Untreated drinking water (usually water being transferred to the water purification facilities) may be transferred using uncovered ground-level aqueducts, covered tunnels or underground water pipes.
2) Water purification facilities: Treated water is transferred using water pipes (usually underground).
3) Water storage facilities such as reservoirs, water tanks, or water towers.
4) Additional water pressurizing components such as pumping stations may need to be situated at the outlet of underground or above ground reservoirs or cisterns (if gravity flow is unfeasible)
5) A pipe network for distribution of water to the consumers (which may be private houses or industrial, commercial or institution establishments) and other usage points (such as fire hydrants)

There are many points in a distribution network where leakages can occur and where they can best be monitored **(see Figure 2).**



Source: Ranhill [11]

Figure 2: Typical Losses from a Water Supply System

2.8 IWA [12] Standard Terminology for Water Losses

Any discussion relating to water losses must be preceded by a clear definition of the water balance components. Drawing on the best practice from many countries, the International Water Association (IWA) Task Force produced a standard approach for Water Balance calculations (table 2), with definitions of all terms involved [13,14] .

11 Water utility Performance Report for 2008/2009
This figure is obtained from auditors' calculations based reported production and NRW figures as provided EWURA in the 2008/09 report (Refer Appendix 2).
More documents can be found in the reference chapter
MOU refers to the Memorandum of Understanding between MOW and the UWSSAs for the period 2008 – 2011 (signed January 2009).
Water Supply and Sanitation Act of 2009.
National Water Policy of 2002
MOU refers to the Memorandum of Understanding between MOW and the UWSSAs for the period 2008 – 2011 (signed January 2009).
Water Supply and Sanitation Act of 2009.
Memorandum of Understanding-January 2009
National Water Policy of 2002

12 See Assessing non-revenue water and its components: a practical approach; International Water Association; August 2003; p. 50f.

13 Alegre H., Hirner W., Baptista J.M. and Parena R. (2000) Performance Indicators for Water Supply Services. IWA Manual of Best Practice. ISBN 900222272

14. Lambert A. and Hirner W. (2000): Losses from Water Supply Systems: Standard Terminology and Recommended Performance Measures. IWA Website, www.iwahq.org.uk/bluepages

Table 2. IWA Standard International Water Balance and Terminology

System Input Volume	Authorised Consumption	Billed Authorised Consumption	Billed Metered Consumption (including water exported)	Revenue Water
			Billed Unmetered Consumption	
		Unbilled Authorised Consumption	Unbilled Metered Consumption	
			Unbilled Unmetered Consumption	
	Water Losses	Apparent Losses	Unauthorised Consumption	Non-Revenue Water (NRW)
			Metering Inaccuracies	
		Real Losses	Leakage on Transmission and/or Distribution Mains	
			Leakage and Overflows at Utility's Storage Tanks	
			Leakage on Service Connections up to point of Customer metering	

Abbreviated definitions of principal components of the IWA water balance are as follows:

- System Input Volume is the annual volume input to that part of the water supply system
- Authorised Consumption is the annual volume of metered and/or non-metered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorised to do so. It includes water exported, and leaks and overflows after the point of customer metering.
- Non-Revenue Water (NRW) is the difference between System Input Volume and Billed Authorised Consumption. NRW consists of:
  - o Unbilled Authorised Consumption (usually a minor component of the Water Balance)
  - o Water Losses
- Water Losses is the difference between System Input Volume and Authorised Consumption, and consists of Apparent Losses and Real Losses
- Apparent Losses consists of Unauthorised Consumption and all types of metering inaccuracies
- Real Losses sometimes called "Physical losses" or "leakage" are the annual volumes lost through all types of leaks, bursts and overflows on mains, service reservoirs and service connections, up to the point of customer metering.

Real Losses include leakage on transmission and distribution mains; leakage and overflows from storage tanks; and leakage on service connections up to the customer's meters.Leakages from transmission and distribution mains are usually large events so they are reported quickly by the public. They can cause serious damage unless they are repaired quickly. Less conspicuous types of leakage are more difficult to detect and repair.

Apparent losses, sometimes called 'Commercial losses', include water that is consumed but not paid for by the user. In most cases, water has passed through the meters but is not recorded accurately. In contrast to leaks or reservoir overflows, the lost water is not visible, which leads many water utilities to overlook commercial losses and instead concentrate on physical losses.

Commercial losses can amount to a higher volume of water than physical losses and often have a greater value, since reducing commercial losses increases revenue, whereas physical losses reduce production costs. For any profitable utility, the water tariff will be higher than the variable production cost. Thus, even a small volume of commercial loss will have a large financial impact.

An additional benefit in reducing commercial losses is that it can be accomplished quickly and effectively.

2.8.1 Calculating Water Losses

Water loss is expressed as:

- a percentage of net water production (delivered to the distribution system)
- as m3/day/km of water distribution pipe network (specific water loss)
- Others

- m3/day/connection
- m3/day/connection/m of pressure

Water loss as a percentage of net water production is the most common. However, it could be misleading for systems with different net productions with the same amount of real and apparent losses.

2.8.2 Monitoring of UWSSAs by MoW and EWURA

Any implementation process needs to be responsive to the planned activities, outputs and outcomes that ultimately define success or failure in meeting targets and objectives of this entiy. A successful program therefore requires timely and accurate feedback so that appropriate interventions can be made. A continuous monitoring process allows the sector to learn so that it can focus on the identified weaknesses or shortcomings while also identifying unforeseen opportunities.

According to the policy framework, data collection is a responsibility of implementing agencies, such as UWSSAs. Data is expected to be analyzed at each level of the implementing agency and stored in the Ministry's sub sector databases.

MoW and EWURA based on data received from UWSSA, analyses and provides decision on technical advice and support to UWSSAs for improvement; the same data are used by EWURA for assessment of the performance of each UWSSA against agreed targets and standards in the performance agreement.

CHAPTER THREE
AUDIT FINDINGS

This chapter presents our findings as answers to the audit questions shown in Chapter 1 of this report. The findings are related to the accounting for water losses, adequacy of inspections, repair, preventive maintenance and actions taken to reduce water losses.

3.1 Monitoring Systems for Water Distribution to Reduce Water Losses

Monitoring of NRW involve accounting for water losses through measuring actual water lost and compare against set standards and taking suitable corrective actions to reduce the deviations.

3.1.1 Performance Measurement of the UWSSAs

NRW is a key performance signal of efficiency. According to the MoW, the recommended level of NRW for UWSSAs is less than 20%.[15] This target is supposed to be achieved by all UWSSAs by 2015. EWURA and UWSSAs agreed on intermediate targets that are to be achieved each year. The intermediate targets of NRW for the eight audited UWSSAs are as read in the MoU and shown in Table 3 below.

Table: 3. UWSSAs Annual NRW Targets for the Year 2008 - 2010

UWSSAs	Ministry target (%)	Target MoU 2007/08	2008/9	2009/10	Actual 2007/08	2008/09	2009/10
Morogoro	20	32	29	29	27	24	29
Dodoma	20	40	35	35	38	44	43
Tanga	20	27	27	24	27	25	25
Lindi	20	44	44	36	46	40	41
Moshi	20	28	28	27	29	33	29
Mwanza	20	33	33	30	37	44	49
Kigoma	20	35	30	25	37	34	56
DAWASCO	20	38	40	35	55	57	54

Source:
UWSSAs Annual reports, 2007/8, 2008/9 and 2009/2010, EWURA Report 2008/09 and MoU between UWSSAs and MoW

The targets set by all the UWSSAs are below the Ministry's Standard of 20% as shown in Table 3 above. The NRW targets for Tanga and Moshi are close to the Ministry's Standard (i.e. 24-29). For most UWSSAs the targets set are far from the standard but the targets have not been achieved. For the three consecutive years, there was no significant improvement in reduction of NRW trends for most UWSSAs, especially those with NRW values above 30%.

Interviews with UWSSAs officilas revealed that the main causes of Non Revenue Water were:
- Old infrastructures leading to leakages
- Illegal connection and meter by pass
- Meter under registration.
- Water theft

15 EWURA: Water Utilities Performance Report for 2008/09. Often, the NRW target is chosen arbitrarily, without any real consideration of cost implications or whether it is achievable. Identifying the economic level of NRW is essential to setting the initial NRW target, and it requires a comparison of the cost of water being lost versus the cost of undertaking NRW reduction activities.

- Shallow depth of the distribution pipes which makes them exposed to erosion and destruction during road grading and by heavy trucks and cars movement.
- High percentage of unmetered customers particularly in Kigoma, Morogoro and Lindi.
- Inaccurate Customer data base which makes it extremely difficult to track all the customers especially those deemed to be inactive and yet very many of these are most likely consuming water illegally.

3.1.2 Accounting for water losses

The Memorandum of Understanding between UWSSAs and MoW requires the Water Authorities to continually monitor water production in terms of quantity and quality (MoU [16]). Also as per the Water Act, the Authorities are supposed to install water meters for the purpose of measuring the amount of water produced and supplied to the customers (Water Act 2009 [17]).

Furthermore, the lease agreement between DAWASA and DAWASCO requires DAWASA to install bulk meters in all areas of distribution and hand them over to DAWASCO to operate.

The system to account for water losses involves presence of clear block mapping, availability of bulk meters for quantification of water produced and supplied to different zones or areas, customer metering and reading the meters for billing the customers.

Installation of Bulk Meters and Zoning

One UWSSA, Morogoro, didn't have block maps/zones. The remaining UWSSA's audited (i.e. 7 out of 8) have block maps indicating zones. However, block maps were not updated to capture current developments, and thus the network is not clearly known to the staff involved in the management of water distribution networks. Table 4 below illustrates the status of various UWSSA on installation of bulk meters and zoning.

Table 4: Bulk meter Installation and Zones status 2009/10

UWSSAs	Block maps/ zones available	Bulk meters installed	Comments
Morogoro	No	No	
Mwanza	Yes	Yes	Data are not often read from bulk meter
Dodoma	Yes	Yes	
Tanga	Yes	Yes	Network overlapping
Moshi	Yes	Yes	
Kigoma	Yes	No	Network is not updated in the block map
Lindi	Yes	No	
Dar es Salaam	Yes	Partly	Bulk meter not used

Source:
UWSSAs Annual Reports 2009/2010

16 MOU refers to the Memorandum of Understanding between MOW and the UWSSAs for the period 2008 – 2011 (signed January 2009).
17 Water Supply and Sanitation Act of 2009.

Three UWSSAs (Lindi, Kigoma and Morogoro) have not installed bulk meters at the production and distribution points. In these UWSSAs, the quantity of water produced is estimated based on the installed pump capacity. In Morogoro, the gravity and pumping systems are interlinked in some areas of service in the way the authority failed to know where exactly the connection point was because of absence of layout map of the distribution system. In Tanga UWSSA, there is an overlap of pipe networks receiving water through different bulk meters. Similarly, in Dar es Salaam (DAWASCO), overlapping of networks among zones (that is Operational Areas) is widespread. During the site visit in Mwanza, it was observed that the majority of the bulk meters were not working.

Due to the overlap of the networks, the absence of bulk meters, and defective or non-operational bulk meters, the authorities can neither correctly measure the amount of water that flows into the operational areas nor accurately account for water losses for each of the areas. Also, the authorities can not accurately quantify volumes of water produced and distributed to different zones/areas.

NRW data are estimated by taking the difference from the estimated production volumes and the estimated billed volume for the particular period.

The magnitude of errors arising from estimations in production flows and consumption can be seen from the experience of Dodoma where NRW changed from 30% (in 2007) to 48% (in 2008). The NRW in 2007 was calculated based on pure estimates whereas in 2008 NRW was computed based on measurements from bulk meters.

It is also difficult to identify the active and inactive customers resulting into more inactive customers. Like for Dar es Salaam, 23 bulk meters were installed at various locations by DAWASA and handed over to DAWASCO in July 2010. However during the audit it was found that the bulk meters are not operational.

Area managers, therefore, cannot account for water losses since the installed bulk meters are not used to measure the water that enters into service areas. This means DAWASCO can neither identify areas with severe losses nor break the losses into smaller components as defined in the IWA Standard Water Balance.

With the current situation, UWSSAs can only know the amount of total NRW by subtracting the billed water from water pumped from the production plant. UWSSAs cannot identify locations where significant losses occur. This problem resulted into persistent water losses over the years as indicated in Table 3.

Customer metering and Meter reading efficiency

For accurate accounting of the water consumed by the customers, all customers need to have meters which have to be read on monthly basis for proper billing.

Four UWSSAs audited (Mwanza, Dodoma, Tanga and Moshi) have metered all their customers. Kigoma, Dar es Salaam, Lindi and Morogoro have not managed to meter all their customers. In addition, Kigoma, Morogoro and Dar es Salaam have not been able to read all the metered connections as illustrated in Table 5 below.

Table 5: Customer metering as of 2009/10

UWSSAs	Total No. of Connections	%metered Connections	Meter reading efficiency (%)
Morogoro	21,077	80	92
Mwanza	30,192	100	100
Dodoma	20,468	100	100
Tanga	22,187	100	100
Moshi	17,324	100	100
Kigoma	8,115	42	50
Lindi	2,171	31	100
Dar es Salaam	145,897	79.4	60

Source:
UWSSAs Annual Reports 2009/2010,EWURA Regional Water Utility Performance Report 2009/2010

Review of documents revealed that partial metering is due to lack of priorities in installation of meters. This is evidenced by the fact that some UWSSAs like Kigoma, Morogoro, DAWASA do not regularly budget for meters and some do not buy and install them despite being in their respective budgets. In addition, Lindi failed to install 200 meters for the fear of early damage to the meters which could be caused by highly turbid water. Installation of meters was also halted to avoid meter under-registration caused by low pressures (low water flowrate).

Unmetered customers pay a flat rate based on estimated monthly consumption. This could result into inaccurate billing leading to either commercial losses or overcharging of customers.

According to interviews with UWSSAs officials, low meter reading efficiency i.e number of meters read compared to the total number of meters installed. The low values were attributed to the following reasons:

- Big work load to meter readers
- Defective meters
- Denied access to household premises
- Failure to locate customer premises
- Customer database was not updated

Five (5) UWSSAs (i.e. Moshi, Tanga, Mwanza, Dodoma, and Lindi) have 100% meter reading efficiency.The first four UWSSAs are in category A and uses data loggers for meter reading. Data loggers [18] minimize meter reading errors, increases coverage of reading, reduces billing processing time.

3.1.3 Data Analysis

UWSSAs are expected to analyze the trends of NRW and determine the causes of water losses. Furthermore, based on IWA standards of water loss calculations, the UWSSAs are expected to identify all components (both physical and commercial losses) that contribute to water losses. Knowledge of the components and causes would assist the UWSSAs in setting strategies and performance indicators for reducing water losses.

18 Data loggers is an equipment which is used for recording reading from water meter.

Based on the audited UWSSAs water losses are caused by leakages, water theft, illegal connections and meter under registration (i.e. meter inaccuracies especially at low pressures). However, UWSSAs don't know how much each component contributes to NRW.

Some UWSSAs such as Moshi, Dodoma Lindi and Mwanza have analyzed the causes and have documented strategies for reducing NRW. However, the strategies developed have no specific performance indicators that aim at addressing the root causes of NRW (i.e. components of NRW).The implementation of the strategies for the three UWSSAs is yet to take off.

Inadequate NRW accounting system in place has resulted into failure to identify where, why, how and how much water is being lost. As a result the UWSSAs have not put in place interventions that would minimize revenue losses caused by NRW.

3.1.4 Reporting to Ministry of Water and EWURA

UWSSAs are answerable to the Board of Directors appointed by the Minister responsible for water. Reports from UWSSAs include Monthly, Quarterly, Annual Reports and ad hoc information required by MoW and EWURA. For the purpose of evaluation, MoU requires UWSSAs to submit a monthly report to the Ministry of Water and EWURA before 14th of the following month. The MoW and EWURA have set out formats for monthly and annual reporting of their performances through indicators in Maji Information System (Maji's database). The database provides a comprehensive set of technical, commercial, financial and personnel data. The annual report submission date agreed is by 30th September of each year.

According to EWURA Reports for Regional Water Utilities Performance reports reviewed 2008/09 , it revealed that three UWSSAs (Lindi, Tanga and DAWASCO) submit their annual reports in the 2nd week of October where as Mwanza and Morogoro submitted their annual reports in the first week of October contrary to the agreed date of 30th September.

MoW requires UWSSA to submit the annual report in the agreed format in which section three of that format requires UWSSAs to provide information of the implementation of the preventive maintenance, that include Meter testing, replacement and repairs.

During the audit the audit team observed that contents of the reports submitted by UWSSAs do not confirm to the requirements of the MoU. The reports do not provide information regarding preventive maintenance. Neither EWURA nor MoW has enquired the UWSSAs for not providing such information. Because of this, EWURA/MoW cannot advice on the issues of preventive maintenance.

Accuracy of Information Provided by UWSSAs

According to the MoU between the MoW and UWSSAs, all UWSSAs are supposed to; provide reliable information in all their annual reports. Where there are doubts with respect to any piece of information, there should be clear expressions on the unknown reliability or doubtfulness respectively.

Reported figures on the amount of water produced are estimated based on rated capacities of the pumps and the duration of pumping. Pump efficiencies may vary greatly with age and when there are power fluctuations whereas the measurements of pumping duration are also prone to inaccuracies or human errors.

Likewise, high proportions of unmetered connections contribute to doubtfulness in the accuracy of information regarding billed water. Since NRW is computed based on amount of water produced and billed the estimated values of NRW provided by the UWSSAs under these circumstances cannot be free from doubtfulness. However, review of various reports submitted by UWSSAs to EWURA revealed that none of the UWSSAs have clearly expressed these doubts.

3.1.5 Cost of Producing NRW

In order to clearly understand the implications of Non Revenue Water, three figures are critical. These include: the weighted average tariff; production cost; and operational cost. The commercial losses are always valued using the weighted average tariff because any reduction in these loses results in proportional increase in revenue. On the other hand, the value for physical losses may not always be related to the weighted average tariff. In systems with completely satisfied demand, any reduction of physical losses would only lead to a reduction in production costs (mainly electricity and Chemicals)

Based on the reported Annual Water Production, NRW (%) and Cost of Production per cubic metre obtained from EWURA, the audit team has estimated the Cost of producing NRW for the years 2007/2008, 2008/2009 and 2009/2010 for all UWSSAs to be TShs 13 Billion, TShs 18 Billion and TShs 19 Billion respectively (Refer Appendices 2, 4 and 6). These figures exclude the the acceptable NRW levels of 20%. This implies that the UWSSAs spend up to TShs 1.5 Billion every month to produce water which is lost.

3.1.6 Loss of Revenues associated with NRW

According to the Annual Water Production reported for the year 2007/2008, 2008/2009 and 2009/2010 , NRW (%) and the average tariffs, and assuming that all the NRW were supplied to customers, billed and paid for, the revenues generated would be TShs 28 Billion, TShs 33 Billion and TShs 32 Billion respectively (Refer Appendices 3, 5 and 7). This means, on average, the UWSSAs are losing revenues worth over TShs 2.5 Billion per month).

3.2 Adequacy of Inspections Conducted

Inspection refers to examination of water works or structures in order to detect inherent defects. Inspections also help reduce water loss frequency and severity through recommended water loss prevention and reduction procedures. In order to reduce water losses through leakages UWSSAs are expected to carry out regular inspections and maintenance of the distribution system. Inspections can adequately be conducted if the inspectors are well supported and equipped to detect irregularities in the networks.

3.2.1 Empowerment and Support to Inspectors

In order to adequately carry out their duties, the inspectors [19] need to have adequate skills that will enable them detect leakages, illegal connections and damage in the water supply network. UWSSAs managements are expected to provide training of technical staff so as to provide and/or enhance their skills.

19 Inspectors have various names at different UWSSAs. These include Leak Control Teams, Repair teams, Leak Teams, Leak Control Teams and Patrol Teams. These are mainly plumbers, artisans, technicians, engineers and commercial assistants depending on the size of the pipe to be inspected.

Training for UWSSAs Inspectors

During the audit some UWSSAs management like DAWASCO claimed to have a training programme in place but it was not available for verification. Inspectors are seldom given chances to attend the training, and most staff who attends these training is those who are not directly involved with the day to day inspection for leak detection. The resources (funds) set for inspectors are usually reallocated to other staff especially those from the headquarters and the members of the Board of Directors. According to the interviews with DAWASCO inspectors in 11 operation areas visited it was found that for the past three years covered in this report training of inspectors has been conducted only once. This training was held in 2010 and was limited to inspectors working in four operational areas. In particular, this was a study tour where inspectors visited other water utilities in other regions to learn how they carry out their operations.

Unlikely, other regional UWSSAs like Tanga and Moshi, training has been given to various staff at various levels including inspectors. In addition, training has been provided to members of the Boards of Directors UWSSAs of Mwanza, Tanga and Moshi. Most of the technical staff from other UWSSAs who attended the training were heads of sections and technical managers. These officers were expected to provide on-the-job training to junior staff. However, there is no evidence that on-the-job training have been conducted.In some UWSSAs (e.g. Lindi), inadequate funding has been cited as the main reason for insufficient training opportunities given to inspectors.

Staffing

In order to efficiently detect leakages, illegal connections and damage in the water supply network the UWSSAs management have to provide sufficient staffing in operation areas.

During this audit the team observed that out of eight UWSSAs only DAWASCO was found to have insufficient staff. The audit team visited 11 out of twelve DAWASCO operational areas. In most areas, the audit team found that staffing is inadequate to the point that the Commercial Assistants perform duties of technicians. Four areas out of 11 had area engineers; seven areas did not have area engineers. In particular, Ilala area has never had an area engineer since DAWASCO was established in 2005. The work of the engineers, in these areas, has been done by technicians and artisans.

According to the interview with DAWASCO officials, insufficient number of staff is caused by staff turnover and lack of incentives to retain the qualified staff.

Allocation of Working Tools and Equipment

Inspectors need working tools to carry out their duties efficiently like detecting leakages, illegal connections and damage in the water supply network. During the audit, interview with the officials from the eight audited UWSSAs, the officials claimed that they did not have equipment for detecting underground leakages (leak detection tools)

However, it was also revealed that the allocation of resources was not done based on the workload of the particular area. This case was found in DAWASCO, due to its bigger size DAWASCO is divided into 12 operational areas but it does not allocate resources based on workload of an operational area. For instance, two motor vehicles and two motor cycles were allocated to every area of operation within DAWASCO despite the variation of workload for various operational areas. These two vehicles are used by all staff in the area, one car is used by the area manager and other car is used by other staff. According to the interviews with DAWASCO officials, it is very difficult for them to conduct water

network surveys which help in leakage detection because by doing that the vehicle or a motor cycle and staff will be taken for the whole day while freezing other activities. As a result, most leakage repairs are done on the reactive and ad hoc basis rather than a proactive way based on planned water network surveys.

3.2.2 Roles and Responsibilities of Inspectors

For the inspectors and other staff to perform their functions well, there is a need to have a well documented scheme of service which spells out the roles and responsibilities of staff. To ensure adherence to roles and responsibilities, UWSSAs need to supervise the staff and conduct staff performance appraisal regularly.

During the audit it was observed that all the UWSSAs have schemes of service in which roles and responsibilities are well elaborated. However, none of the UWSSAs have conducted staff performance appraisal for the three years covered in this report.

Absence of performance appraisal prevents the UWSSAs from analyzing employee's recent successes and failures, personal strengths and weaknesses, and suitability for promotion or further training. It hinders the assessment of employee's performance in job based considerations and demoralizes the staff.

3.2.3 Inspection of Water Networks

For effective control of leakage, inspectors' teams of the UWSSAs are supposed to conduct inspections on the performance of the entire water distribution network. In order to effectively fulfil this obligation UWSSAs are expected to have inspection plans in place. A good plan for the daily inspection of the water network can be an effective tool for the control of leakages, illegal connections and damage in the water supply network if it is properly implemented. Best practices require UWSSAs to have network maps to assist them in planning and implementing the inspection programmes. Inspection teams are also expected to prepare inspection reports.

According to the interviews with officials in the audited UWSSAs, none of the UWSSAs have inspection plans/schedule and checklists. Inspection is done either on ad hoc basis or based on known of history of leakage/theft incidents. The surveys for leaks detection are not regularly done but inspectors go to fix the leaks when there are customer complaints. None of the UWSSAs have developed any checklists or documented guidelines for the inspectors to use in their daily inspection activities.

The inspectors' teams do not conduct proactive inspections on the performance of the entire water distribution network. They get most of the information on leakage from the commercial assistants [20] . There are no written reports that give details of the inspection conducted. The only record that can provide information on the inspection is the register that keeps information on reported leaks, bursts and associated remedies. Lack of properly planned inspections makes identification of key risk areas and crafting of water losses preventive measures difficult to implement.

In controlling illegal connections Moshi, Tanga, Mwanza, Dodoma and DAWASCO have initiated innovative schemes for reporting water theft, through text messaging. Once verified, the informer is given a financial reward for each illegal connection reported and verified. This form of the relationship with the public might have contributed to the improvement of the NRW for the three UWSSAs of Moshi, Tanga and Dodoma among the audited authorities. (See Table 2).

20 Commercial assistants are responsible for meter reading

3.3 Adequacy of Repair

Repair is conducted with the objective of retaining or restoring an item in or to a state in which it can perform its required function. In an ideal situation, the following set up is expected to have in place a team of skilled staff mainly plumbers who will perform the following tasks:-

- Searching/detecting leak by going through the whole network (on foot, bicycle or motor cycle)
- Sketching the location of the identified leaks and reporting to the leak repair and maintenance supervisor.
- The team will make a follow up and submit monthly reports that will capture number of leaks identified and repaired, how long the leaks have existed its location and frequency of occurrences. For the team to perform well it requires to have the following:
    - Network map or a good knowledge of the entire network in order to be able to reach the entire network from pumping station, transmission mains, bulk transfer, distribution and customer service lines up to the point of customer connections.
    - Transport like bicycle/motor cycles
    - Forms/ checklists – to ease repair and record keeping concerning leaks.

During the audit it was found that repair is hardly conducted in many UWSSAs as staff do not have good knowledge of the network and most UWSSAs have no network maps to ease reaching the networks and indentifying the faults. Because of that, it can be said that water networks in many UWSSAs audited deteriorate or do not perform their required functions due to inadequate repair.

3.3.1 Addressing of Water Leakage

Water leakage means water that is lost because of breaks or leaks in pipelines. UWSSAs are responsible for calculating the amount of water lost on each reported leak based on the date the leak was discovered, the size of the break, and the water pressure at the point of distribution system.

The audited UWSSAs have leak control teams and registers which are used to record leaks and breaks that are reported during the working days. The leaks that are reported after working hours, during the week ends and public holidays are usually not recorded. Also this register does not capture important issues like the time when the leakage was reported and the time when the leak was repaired.

Four (4) out of the eight (8) UWSSAs audited have established toll free telephone lines to receive calls from customers who report on the leaks and breaks. All the four UWSSAs showed good performance on NRW for 2010 except Mwanza. Mwanza toll free line has not been working for eight months by the time the audit team visited Mwanza UWSSA. In general, customers who report the leaks could be doing so because of the good relationship between the authorities and its customers. UWSSAs that do not have toll free lines are DAWASCO, Morogoro, Lindi and Kigoma. And these UWSSAs have experienced a poor performance of managing NRW as showed in Table 3.

Leak Response Time

According to the MoU of 2008 – 2011, on reliability of supply, the UWSSAs are supposed to restore supply at the minimum time of 24 hours after emergency lock-off.

In the registers, UWSSAs do not record time of reporting, time when the leak started and the time when the leak was repaired. Because of this UWSSAs cannot estimate the duration of the leaks and the amount of water that is lost through leakage. Furthermore, it was learnt that lack of knowledge of the actual response time makes it difficult for the UWSSAs to formulate strategies for reducing the duration of the leaks repair.

According to officials from the UWSSAs this problem is prompted by the old water network and difficulties in getting materials for repair. Materials needed for repair of old water pipes are not easily available from local suppliers and takes the utilities sometimes to get the required materials. In the case of DAWASCO, the procurement and storage of repair materials is centralized. When leaks and bursts occur the Area Managers have to request for the materials from the central store. Due to bureaucratic procedures involved it takes more than 24 hours for the leaks and bursts to be repaired. In view of these circumstances the water authorities continue to suffer from water losses.

Pressure Management

Management of pressure is one of the biggest questions often faced by water service providers which results to pipe bursts or leaks. The problem is worsened when there is a big variation in topography of the area of water supply as was evidenced in Morogoro, Mwanza and Moshi.

According to the MoU licensees (UWSSAs) are required to maintain a pressure in the pipes that will ensure that customers receive adequate supply of water. The maximum pressure should be 0.5 bars (i.e. 5 metres head pressure) at the ingoing pipe to the premises with a minimum flow of 7 litres per minute. A maximum pressure should not be more than 2 bars (20 metres head pressure) so as to protect consumers from damages due to excessive pressure.

However, the UWSSAs do not perform adequate pressure management activities. By virtue of these circumstances it is difficult to control all leaks and bursts caused by water pressure.

3.3.2 Adequacy of Planning and Budgeting for Repair

A budget is the guiding tool to monitor the operation of an entity. The budgetary allocation provided is adequate when it allows the activities to meet prescribed state of performance standards timely. The UWSSAs are responsible for preparing the budget for their entire operations. Repair is one of the components to be given priority in the UWSSAs' budgets.

According to operational guidelines for UWSSAs provided under the MOU between MoW and UWSSAs, repair is priority number 7 in preparing the allocation of funds for the UWSSAs' and preventive maintenance is priority number 4. This implies that UWSSAs are expected to spend more funds on preventive maintenance so as to reduce spending on repairs.

The Table 6 below shows the budget set aside for the entire repair and maintenance for eight UWSSAs for three consecutive years covered in this report.

Table 6: UWSSAs [21] Budgets and Actual Expenditure on Repair and Maintenance

UWSSAs Budgets and Expenditure (million TShs)						
	Morogoro	Lindi	Tanga	Moshi	Dodoma	Kigoma
Budget						
2007/08	145	26.4	56.9	361.2	54	51
2008/09	117	14.3	79.1	315.6	67	65
2009/10	46	20.4	86.5	285.2	85	78
Actual expenditure						
2007/08	145	52.8	99.1	126.4	31	48
2008/09	117	22.1	99.5	213.0	68	65
2009/10	75	11.0	193.2	206.4	46	76
Expenditure/budget						
2007/08	100%	200%	174%	(35%)	57%	94%
2008/09	100%	154%	125%	(67%)	101%	100%
2009/10	163%	(54%)	223%	(72%)	54%	90%

Sources:
Auditor's analysis of UWSSAs' Audited financial statements of the UWSSAs for 2007-2010

Document review revealed that there is inadequate fund allocation for repairs of water networks. Enormous variances between the budgets and the actual expenditures have been experienced by most UWSSAs (refer Table 6 above). This implies that the site condition inspections are not adequately conducted with a view to come up with realistic estimates regarding repair activities.

In addition, for most of the UWSSAs repair and maintenance are combined together as one component in the budget instead of being addressed as two separate and distinct components according to their priority in the MoU. Tanga is the only UWSSA which separates these two components. As a result, the UWSSAs could not evaluate the budget performances in maintenance and repair works as distinctive priority items and come up with strategies to monitor and control the problematic area in water leakage.

3.3.3 Organization of Repair Activities

Repair activities need to be organized well for proper follow up. Interviews with officials from all eight audited UWSSAs indicated that there are teams responsible for carrying out repair activities. However, when service pipeline bursts or breaks occurs after working hours, during holidays or week-ends they are not promptly attended because there is no standby team tasked to work during the off days. When the distribution main (big pipe) bursts it is attended instantly since it affects a bigger population. This implies that all the UWSSAs are prone to greater water losses if bursts occur after working hours, during holidays and during the week-ends.

21 The data on Budget on repair and Maintance for DAWASCO and MUWASA (Mwnza) were not available at the time of this audit.

Furthermore inspectors of eleven DAWASCO operational areas visited revealed that one of the main problems they face is inadequate stocks of pipe and leak fixing equipment and materials. According to the inspectors, most of these equipments were centralized at DAWASCO headquarters. Due to this circumstancess, when bursts or leaks occur it takes some time because fixing involves a long process of requesting for the materials from the central store. Centralizing the repair and maintenance materials hampers the efficiency in attending the network faults timely and stopping water from leakage.

All the audited UWSSAs do not give as much attention to leaks as compared to the attention given customer billings and revenue collection. Inadequacies in the timeliness and quality of repairs conducted could be a contributory factor in the growing magnitudes of NRW experienced by UWSSAs.

3.3.4 Quality Assurance System of the Repair Work

Quality assurance system provide necessary guidance to ensure that each repair meets the minimum standards adopted and any specific requirements established to ensure that repairs meet minimum codes, standards, and are performed at acceptable quality level. The following quality control procedures should be implemented by the repair operations:

- The owner and/or service manager/foreman have complete control and responsibility over the work performed within the facility.
- Every repair performed must be inspected by an approved quality assurance technician during and/or at final completion of the repair.
- Follow-up inspections must be made of unsatisfactory work by the approved quality assurance technician to ensure an acceptable quality level has been obtained.
- Quality assurance technicians must use a quality control checklist for all repairs.

Interviews with officials from the audited UWSSAs revealed that there is no formal quality assurance framework. The quality of materials used for water network repairs are not checked. No laboratory tests are conducted to ensure the materials received for field operations are of reliable quality, the only test that is done is pressure test to check if the joints are well sealed and do not leak. This is done after repairs.

Furthermore, the quality of work is also unsatisfactory due to the following circumstances found in the ground:

- Lay pipe at a depth of less than 3 feet as required by IWA;
- Untested sleeves at road crossings in which IWA needs strong sleeves;
- Faulty workmanship and poor quality materials, sizing and layout; and
- Lack of pipe replacement policy and implementation.

By virtue of these circumstances the problem of water losses will continue due to substandard materials and poor workmanship.

3.4 Preventive Maintenance

Preventive maintenance refers to care and servicing for the purpose of maintaining equipment and facilities in satisfactory operating condition by providing for systematic inspection, detection, and correction of early failures either before they occur or before they develop into major defects.
Recent studies have shown that preventive maintenance is effective in preventing age related failures of the equipment [22].

3.4.1 Planning and Budgeting for Maintenance

This section focuses on how the UWSSAs fund the maintenance activities from their annual budgets. This includes determining whether allocation of funds to maintenance activities is efficiently and effectively done.

A complete maintenance plan is expected to include the following components

- Maintenance policy – Highest-level document, typically applies to all the UWSSAs.
- Maintenance strategy – A maintenance plan developed, normally reviewed and updated every 1 to 2 years.
- Maintenance program – Applies to an equipment system or work center, describes the total package of all maintenance requirements to care for that system within the UWSSAs.
- Maintenance checklist – List of maintenance tasks (preventive or predictive) typically derived through some form of analysis, generated automatically as work orders at a predetermined frequency [23].
- UWSSAs' managements are required to prepare the annual budgets and plans which shall be approved by the Boards of Directors. The budgets so approved are supposed to be submitted for information to MoW and EWURA by 30th of every year. The allocations of funds within UWSSAs are supposed to follow the following priorities.
    i. Personal emoluments and statutory payment; Utilities;
    ii. Operations;
    iii. Preventive maintenance; water user fees and EWURA Levy, assets valuation new and old as per IFRS;
    iv. Repair and Replacement;
    v. Development and investment [24] .

During the interviews, the UWSSAs officials acknowledged that maintenance interventions need to be analyzed, the causes of malfunction or bursts recorded, so as to guide future procurement decisions and help in deciding whether part or all of the network or plant should be upgraded or replaced based on schedule and program of work. In addition, emergency maintenance occurs when the past routine maintenance has not been done as scheduled and where plant is aging.

However, the audit has revealed that maintenance is not carried out as scheduled. Instead, it is conducted on ad hoc basis when there is system break down. The audit also revealed that there is no maintenance evaluation report produced by any of the UWSSAs that could record the problems they have experienced and recommend on the way forward. Therefore the utilities have insufficient information on maintenance that could guide them in making appropriate plans for the sustainability of their respective water networks.

22 Maintenance, Repair and Operations-Wikipedia, the free encyclopedia
23 Constructing an effective Maintenance Plan-Reliable Plant
24 Memorandum of Understanding-January 2009

The analysis ofUWSSAs budget for three consecutive years covered in this report revealed that there is no separate budget set for preventive maintenance except for Tanga UWSSA which separates the two components of maintenance and repair. Due to this, the UWSSAs have not been able to give the desired preference to preventive maintenance. As a result, most of the expenditure in this budget component has been on ad hoc repairs.

Some physical assets have not been properly treated in the books of accounts. In three UWSSAs (i.e. Lindi, Tanga, Moshi) meters have been expensed rather than being capitalized and recorded in the fixed asset register. Because of this, the management could not determine their respective life spans and budget for their maintenance replacement.

3.4.2 Implementation of the MoU on Preventive Maintenance

According to the Memorandum of Understanding of January 2009 between MoW and UWSSAs, UWSSAs are required to develop and carry out proper maintenance of water networks connected to the supply of water.

Furthermore, the MoU operational guidelines of technical procedures require UWSSAs to ensure that the facilities and infrastructure for water supply are properly maintained and a comprehensive preventive maintenance program is in place.

To implement these, UWSSAs are expected to have clearly updated network maps, updated preventive maintenance schedule, execution of the preventive maintenance and to have a maintenance report as a way of providing feedback and to UWSSAs' managements.

Review of documents showed that, four UWSSAs (i.e. Dodoma, Moshi, Kigoma, Morogoro) have programmes of preventive maintenance in place. However, the programmes have never been implemented as intended. As a result, UWSSAs have not managed to produce the maintenance evaluation reports that could assist them to identify the risk areas and set strategies to intervene those risk areas. This could also help UWSSAs to determine problematic areas and stock frequently used materials.

The budget allocation for preventive maintenance has been relatively low for all the UWSSAs during the period covered by this audit. There has been an over expenditure in this item. Since preventive maintenance is seldom done, most of the funds were spent on repair.

3.5 Actions Taken to Reduce Water Losses

UWSSAs are responsible for assessment of water loss, preparation of water loss reduction strategies and activities aimed at reducing the losses. This section will explain different actions and UWSSAs strategies that are in place for reducing water losses.

3.5.1 Identification of Key Issues Related to Water Losses

In calculating the amount of water losses UWSSAs, are required to know the contribution of each component to the total losses as defined in the IWA water balance calculation shown in table 2 in section 2.8 above.

Components of NRW comprises of physical and apparent losses. Physical losses are losses through bursts and leaks caused by faulty designs of pipe networks, inadequate pressure management, sub-standard material and ageing of infrastructure. While apparent (commercial) losses are due to unauthorized consumption and metering inaccuracies (i.e. meter under reading at low flows, meter defects).

According to document reviews and interviews with UWSSAs officials it was found that, possible causes of water losses are known to UWSSAs. However, the UWSSAs failed to quantify the contribution of each NRW component into the total figure. The calculation of NRW is based on the system input volume (production) and billed volume in which the difference of the two is what is termed as NRW. This setback was caused by lack of proper strategy for metering, zoning and water losses detection and quantification. Failure to quantify the actual contribution of each cause of NRW resulted into failure to formulate appropriate measures and priority strategies for dealing with the problem.

3.5.2 Plans for Intervention and their Implementation

A NWR Intervention Plan is a document that describes how UWSSAs will control or improve their performance regarding NRW.

According to documents reviewed, only 3 UWSSAs (Lindi, Moshi, Dodoma) out of the 8 audited UWSSAs have strategies in place to reduce NRW. However, none of the 3 UWSSAs have prepared action plans to implement their respective strategies. Furthermore, strategies prepared by Lindi and Dodoma do not focus on each of the components that contribute to NRW. Having the strategy in place without a well defined intervention action plan explaining the targets and timeframe to meet the set target (of 20% by 2015 as stipulated in Memorandum of Understanding of January 2009) will make it difficult to reduce NRW.

3.6 Monitoring of UWSSAs Performance by MOW and EWURA

According to the Water Supply and Sanitation Act of 2009, the Ministry of Water is responsible for coordinating and monitoring UWSSAs strategies and plans. Similarly, EWURA as the regulatory body is responsible for monitoring of water quality and standard of performance in the provision of water supply and sanitation services.

Document review revealed that, EWURA gives recommendations to UWSSAs regarding reduction of NRW. However, the extent to which these recommendations are being implemented is not sufficient. In addition, there is no evidence to show that the MoW has made efforts to put additional pressure on the UWSSAs regarding their conduct in dealing with water losses.

EWURA's influence as a regulator of the UWSSAs has been felt only when the UWSSAs need to review their tarrifs. In such instances UWSSAs have been forced to comply with what EWURA recommends.

CHAPTER FOUR
CONCLUSIONS

The findings presented in the previous chapters give us reasons to draw the following conclusions.

General Conclusion

UWSSAs, EWURA and MoW are still facing challenges to reduce NRW to an acceptable standard in the country. In spite of the many strong indications that there are high levels of NRW in the UWSSAs, the UWSSAs, the Ministry and EWURA have not taken sufficient measures to quantify the losses and have not combated the problem of NRW in a proactive and systematic way.

With the current deficiencies, where UWSSAs fail to quantify the actual impact associated with each of the contributory factors on the total NRW, it makes it difficult to formulate appropriately prioritized strategies for dealing with the problem.

The current strategies being adopted by most UWSSAs to address NRW levels are geared towards addressing apparent losses, in particular, water theft. Such approach cannot achieve the intended target of NRW (i.e. 20%).

Specific Conclusions

The following are specific conclusions:

4.1 The Monitoring Systems for Water Distribution

The UWSSAs have failed to know exactly where, how and how much water that is lost. Therefore the computation and management of NRW is very difficult. This has a cascading effect on the performance of the UWSSAs as a lot of revenue is lost through wastage of water.

4.1.1 Accounting for Water Losses

Some UWSSAs do not have bulk meters at the production and distribution points. Thus UWSSAs cannot quantify amount of water entering and leaving particular zones/areas. The network maps were not updated to capture current developments which make it difficult to manage the water network.

Some installed bulk meters were found not working due to technical faults and lack of coordination among various actors within UWSSAs. Overlapping of area networks has been a common phenomenon within some UWSSAs. This has made it difficult for the UWSSAs to assess the performance of various operational areas.

Not all the UWSSAs have managed to meter all their customers (i.e. 100% metering) thus the billed water has been partly based on estimates which are subjective to errors and eventually commercial loss. In addition, UWSSAs do not adequately manage water pressure in the distribution networks.

4.1.2 Achievements of Targets

All UWSSAs had set the target of NRW below the MoW standard of 20%, However, for the three consecutive years covered in this audit there were no significant improvements in reduction of NRW trends for any of the UWSSAs. The NRW figures provided are questionable as they are subjected to errors.

4.1.3 Formulation and Implementation of Strategies

UWSSAs don't know how much each component of water losses contributes to NRW. Half of the UWSSAs covered in this audit have analyzed the causes of NRW and have documented strategies for reducing NRW but the strategies developed have no action plan accompanied with the specific performance indicators that can be used to monitor the performance. Some of these UWSSAs have implemented the strategies partially whereas some have not.

4.2 Inspections of the networks were not adequately conducted

UWSSAs have not conducted proactive inspections on the performance of their entire water distribution networks. This was due to lack of plans and inadequate support/empowerment to staff through training and provision of necessary working tools and guidelines for their work. Staff responsible for inspection are usually given mixed roles and responsibilities including meter reading and distribution of bills.

4.3 Repair of water network is inadequate

4.3.1 Water leakages have not been adequately addressed

The water leakages that occur after working hours, during the week ends and public holidays are not recorded. The leakage response time has not been recorded. Document review has revealed that in most incidences, it takes more than 24 hours to repair the reported leaks.

Although half of the audited UWSSAs have established toll free telephone lines to receive calls from customers on leaks, not all the lines have been working regularly. Again,UWSSAs do not perform adequate pressure management activities which makes it difficult to control leaks and bursts caused by water pressure .

4.3.2 Budget and Planning of Repair Activities are not appropriately organized

UWSSAs do not allocate separate budget for repair activities. Instead repair is combined with maintenance. Due to lack of proper plans and bureaucratic procedures, pipes and leak fixing materials and equipment have not been readily available to UWSSAs when need arise.This has given room for more NRW even after being reported.

4.3.3 Lack of Quality Assurance System of the Repair Work

There is no formal team which is used to ensure that the quality of the materials received and used for field operations is acceptable. The only quality assurance check that is usually conducted is the pressure test, which is normally done after fixing of the leakage.

4.4 Lack of Preventive Maintenance

Preventive maintenance is the fourth priority which needs a separate budget and implementation plans to minimize adhoc repairs. However, most of the audited UWSSAs have combined preventive maintenance with repairs. As a result, most of the activities carried out by UWSSAs in this budget component were adhoc repairs. This implies that UWSSAs are using a reactive approach rather than proactive approach in maintaining their networks. This approach is based on breakdowns rather than plans.

Despite the lack of priority given to preventive maintenance, neither EWURA nor MoW has made efforts to enquire or recommend for any corrective actions by UWSSAs.

4.5 Inadequate monitoring of UWSSAs Performance

The Water Supply and Sanitation Act of 2009 requires both the Ministry of Water and EWURA to monitor the activities of UWSSAs, including management of NRW and give recommendations.

The recommendations given by EWURA have not been adequately implemented.

EWURA's influence as a regulator of the UWSSAs has been felt only when the UWSSAs need to review their tariffs. In such instances UWSSAs have been forced to comply with what EWURA recommends.

EWURAs reports are mostly based on the data derived from the reports submitted by the UWSSAs on weekly, monthly and annually. EWURA seldom visited the UWSSAs with a view to validate the information regarding NRW that the UWSSAs submit to them. In addition, EWURA do not make follow ups geared at assessing the extent to which their recommendations have been implemented by UWSSAs.

Furthermore, the Ministry of Water has not made substantial efforts to put additional pressure on the UWSSAs regarding their conduct in dealing with water losses.

CHAPTER FIVE
RECOMMENDATIONS

The audit findings and conclusions point out that there are many weaknesses in monitoring and accounting for water losses among UWSSAs.

Similarly, weaknesses are surfacing in the areas of inspection, repair and maintenance of water networks. Therefore, this chapter provides recommendations to the Ministry of Water (MoW), EWURA and UWSSAs regarding the weaknesses pointed out in the previous two chapters. The National Audit Office believes that these recommendations need to be considered if the water distribution to urban areas in Tanzania is to be better managed ensuring that the 3E's of Economy, Efficiency and Effectiveness are achieved in the use of public resources.

5.1 Monitoring and Accounting for Water losses

The UWSSAs should ensure that they appropriately monitor the levels of NRW with a view to minimize them to the set target of 20%.

This can be done by ensuring that:

- A unit is established with the sole purpose of dealing with issues of NRW management;
- Bulk Meters are installed at all points from production point to reservoir point and from reservoir to distribution points;
- UWSSAs are appropriately divided into zones, each to be provided with a bulk meter for recording the amount of water that it receives and zonal area managers to be measured in their performance based on the NRW of their zones .
- Overlapping of networks among various zones should always be avoided and if found necessary a bulk meter accompanied with a non-return valve should be installed at the point of intersection of the two networks.
- All customers to be metered and the meters are read every month in order to issue realistic bills that are based on metered consumption. For efficiency purposes meter reading can be done using data loggers as done in other UWSSAs.
- All key issues related to NRW (i.e. physical losses and commercial losses) are identified and quantified so as to adequately prioritize mitigate measures based impact of the issues and complexity of deploying corrective actions;
- Intermediate targets of NRW established are set based sound analysis of contributory NRW;
- All elements of NRW are investigated and quantified;
- There are plans for data collection, analysis, reporting and use.
- UWASSAs are required to manage Water pressure in the distribution networks inorder to reduce water loss which result bursting of pipies due to poor managed water pressure.s

5.2 Inspection of Water Networks

UWSSAs should ensure that:

- They plan and conduct proactive inspections on the performance of their entire water distribution networks;
- Leaks detection programmes are continued with the goal of testing the entire distribution system regularly; and

- They adequately support/empower the staff responsible for inspection through training and provision of necessary working tools and guidelines for their work.
- Preparation of network map is in place and regularly updated.

5.3 Repair of Water Networks

The UWSSAs should ensure that:

- They properly record all reported/identified leakages and prepare plans to reduce the leakage response time to below 24 hours especially those incidences that occur after working hours, during the week ends and public holidays. This may be achieved by making a shift arrangement whereby a group of staff operate as a standby gang that will attend breakdowns at all times.
- They establish and maintain toll free telephone lines to receive calls from customers who report the leaks and make sure that all the lines are working at all times;
- They instigate proper pressure management activities in order to reduce leaks and bursts caused by high water pressure;
- They make proper plans to ensure that pipes and other leak fixing materials and equipment are readily available when need arise. This can be achieved through arrangements such as framework contracts with suppliers.
- They conduct relevant tests to ensure that quality of the materials received and used for field operations are of reliable quality.

5.4 Preventive Maintenance of Water Networks

In order to reduce the amount of water lost through leaks, UWSSAs should ensure that maintenance and upkeep functions are given high priority throughout the utility. This can be achieved through the following:

- Preparation of a separate adequate budget and implementation plans for preventive maintenance;
- Enhance monitoring functions within UWSSAs to ensure that the plans are implemented.
- To broaden the concept of Maintenance in line with point 4 in the MoU with MoW to also include Replacement (Reinvestment) as a means to avoid leaks in a more value for money way and in the long-term perspective serve customers with more reliable water supply.

5.5 Monitoring of UWSSAs Performance

The Ministry of Water and EWURA should implement the requirement of the Water Supply and Sanitation Act of 2009 by adequately monitoring the activities of UWSSAs including the management of NRW.

- The monitoring should include following up of the extent to which their recommendations have been implemented.
- EWURA should perform validation of the information regarding NRW that the UWSSAs submit to them.
- The Ministry of Water should make efforts to ensure that UWSSAs adequately control water losses.
- Undertake snap short survey on set or agreed performance indicators
- EWURA and MoW should establish quality control and conduct snapshot survey routine to any of the UWSSAs same way they do to petrol station.

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APPENDICES

APPENDIX 1: WATER BALANCE DEFINITIONS

<table>
<tr><td rowspan="8">System Input Volume</td><td rowspan="8">Authorised Consumption

Water Losses</td><td rowspan="2">Billed Authorised Consumption</td><td>Billed Metered Consumption (including water exported)</td><td rowspan="3">Revenue Water</td></tr>
<tr><td>Billed Unmetered Consumption</td></tr>
<tr><td rowspan="2">Unbilled Authorised Consumption</td><td>Unbilled Metered Consumption</td></tr>
<tr><td>Unbilled Unmetered Consumption</td></tr>
<tr><td rowspan="2">Apparent Losses</td><td>Unauthorised Consumption</td><td rowspan="4">Non-Revenue Water (NRW)</td></tr>
<tr><td>Metering Inaccuracies</td></tr>
<tr><td rowspan="3">Real 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 metering</td></tr>
</table>

In the following, all terms used in Figure above are listed in hierarchical order – as one would read the water balance from left to right. Some of the terms are self-explanatory but are still listed for consistency.

System Input Volume
The volume of treated water input to that part of the water supply system to which the water balance calculation relates.

Authorised Consumption
The volume of metered and/or un-metered water taken by registered customers, the water supplier and others who are implicitly or explicitly authorised to do so by the water supplier, for residential, commercial and industrial purposes. It also includes water exported across operational boundaries.

Authorised consumption may include items such as fire fighting and training, flushing of mains and sewers, street cleaning, watering of municipal gardens, public fountains, frost protection, building water, etc. These may be billed or unbilled, metered or unmetered.

Water Losses
The difference between System Input and Authorised Consumption. Water losses can be considered as a total volume for the whole system, or for partial systems such as transmission or distribution schemes,

or individual zones. Water Losses consist of Physical Losses and Commercial Losses (also known as Real Losses and Apparent Losses)

Billed Authorised Consumption
Those components of Authorised Consumption which are billed and produce revenue (also known as Revenue Water). Equal to Billed Metered Consumption plus Billed Unmetered Consumption.

Unbilled Authorised Consumption
Those components of Authorised Consumption which are legitimate but not billed and therefore do not produce revenue. Equal to Unbilled Metered Consumption plus Unbilled Unmetered Consumption.

Commercial Losses
Includes all types of inaccuracies associated with customer metering as well as data handling errors (meter reading and billing), plus unauthorised consumption (theft or illegal use).
Commercial losses are called “Apparent Losses” by the International Water Association and in some countries the misleading term “Non-Technical Losses” is used.

Physical Losses
Physical water losses from the pressurized system and the utility’s storage tanks, up to the point of customer use. In metered systems this is the customer meter, in unmetered situations this is the first point of use (stop tap/tap) within the property. Physical losses are called “Real Losses” by the International Water Association and in some countries the misleading term “Technical Losses” is used.

Billed Metered Consumption
All metered consumption which is also billed. This includes all groups of customers such as domestic, commercial, industrial or institutional and also includes water transferred across operational boundaries (water exported) which is metered and billed.

Billed Unmetered Consumtion
All billed consumption which is calculated based on estimates or norms but is not metered. This might be a very small component in fully metered systems (for example billing based on estimates for the period a customer meter is out of order) but can be the key consumption component in systems without universal metering. This component might also include water transferred across
operational boundaries (water exported) which is unmetered but billed.

Unbilled Metered Consumption
Metered Consumption which is for any reason unbilled. This might for example include metered consumption by the utility itself or water provided to institutions free of charge, including water transferred across operational boundaries (water exported) which is metered but unbilled.

Unbilled Unmetered Consumption
Any kind of Authorised Consumption which is neither billed nor metered. This component typically includes items such as fire fighting, flushing of mains and sewers, street cleaning, frost protection, etc. In a well run utility it is a small component which is very often substantially overestimated.
Theoretically this might also include water transferred across operational boundaries (water exported) which is unmetered and unbilled – although this is an unlikely case.

Unauthorised Consumption
Any unauthorised use of water. This may include illegal water withdrawal from hydrants (for example for construction purposes), illegal connections, bypasses to consumption meters or meter tampering.

Customer Metering Inaccuracies and Data Handling Errors
Commercial water losses caused by customer meter inaccuracies and data handling errors in the meter reading and billing system.

Leakage on Transmission and/or Distribution Mains
Water lost from leaks and breaks on transmission and distribution pipelines. These might either be small leaks which are still unreported (e.g. leaking joints) or large bursts which were reported and repaired but did obviously leak for a certain period before that.

Leakage and Overflows at Utility's Storage Tanks
Water lost from leaking storage tank structures or overflows of such tanks caused by e.g. operational or technical problems.

Leakage on Service Connections up to point of Customer Metering
Water lost from leaks and breaks of service connections from (and including) the tapping point until the point of customer use. In metered systems this is the customer meter, in unmetered situations this is the first point of use (stop tap/tap) within the property. Leakage on service connections might be reported breaks but will predominately be small leaks which do not surface and which run for long periods (often years).

Revenue Water
Those components of Authorised Consumption which are billed and produce revenue (also known as Billed Authorised Consumption). Equal to Billed Metered Consumption plus Billed Unmetered Consumption.

Non-Revenue Water
Those components of System Input which are not billed and do not produce revenue. Equal to Unbilled Authorised Consumption plus Physical and Commercial Water Losses.

(Unaccounted-for Water)
Because of the widely varying interpretations and definitions of the term 'Unaccounted for Water', it is strongly recommend that this term be no longer used. It is equivalent to 'Water Losses' in the Water Balance diagram

APPENDIX 2: ESTIMATED COST OF PRODUCING NRW FOR FY 2007/2008

SN	UWSSA	Annual Production (Million M^3)	NRW (%)	Anual NRW in Excess of 20% (million M^3)	Cost of Production per M^3	Cost of producing NRW (Million TSh)
1	Arusha	15.59	22.0	0.31	228.00	71
2	Babati	1.11	46.0	0.29	270.00	78
3	Bukoba	2.26	52.7	0.74	254.00	188
4	Dodoma	7.95	38.0	1.43	292.00	418
5	Iringa	4.24	46.0	1.10	312.00	344
6	Kigoma	2.99	37.0	0.51	219.00	111
7	Lindi	0.47	46.0	0.12	804.00	98
8	Mbeya	10.36	32.0	1.24	163.00	203
9	Morogoro	8.74	27.0	0.61	399.00	244
10	Moshi	8.44	29.0	0.76	284.00	216
11	Mtwara	1.96	33.0	0.25	506.00	129
12	Musoma	3.86	45.0	0.97	214.00	207
13	Mwanza	13.83	37.0	2.35	297.00	698
14	Shinyanga	3.25	38.0	0.59	283.00	166
15	Singida	1.71	43.0	0.39	702.00	276
16	Songea	2.29	35.0	0.34	220.00	76
17	Sumbawanga	1.80	43.0	0.41	193.00	80
18	Tabora	4.79	28.0	0.38	204.00	78
19	Tanga	9.50	27.0	0.67	287.00	191
20	Dar es Salaam	92.65	55.0	32.43	276.00	8,950
	Total	**197.79**				**12,820**

APPENDIX 3: ESTIMATED VALUE OF NRW FOR FY 2007/2008

SN	UWSSA	Annual Production (Million M^3)	NRW (%)	Annual NRW in Excess of 20% (million M^3)	Average Tariffs per M^3	Price of Lost water (Million TSh)
1	Arusha	15.59	22.0	0.31	306.23	95
2	Babati	1.11	46.0	0.29	361.10	104
3	Bukoba	2.26	52.7	0.74	645.00	477
4	Dodoma	7.95	38.0	1.43	557.00	797
5	Iringa	4.24	46.0	1.10	547.19	603
6	Kigoma	2.99	37.0	0.51	463.00	235
7	Lindi	0.47	46.0	0.12	650.00	79
8	Mbeya	10.36	32.0	1.24	294.60	366
9	Morogoro	8.74	27.0	0.61	448.00	274
10	Moshi	8.44	29.0	0.76	324.00	246
11	Mtwara	1.96	33.0	0.25	559.64	143
12	Musoma	3.86	45.0	0.97	438.00	423
13	Mwanza	13.83	37.0	2.35	297.00	698
14	Shinyanga	3.25	38.0	0.59	283.00	166
15	Singida	1.71	43.0	0.39	465.00	183
16	Songea	2.29	35.0	0.34	220.00	76
17	Sumbawanga	1.80	43.0	0.41	337.20	140
18	Tabora	4.79	28.0	0.38	650.00	249
19	Tanga	9.50	27.0	0.67	439.00	292
20	Dar es Salaam	92.65	55.0	32.43	689.50	22,359
	Total	**197.79**		**45.90**		**28,005**

APPENDIX 4: ESTIMATED COST OF PRODUCING NRW FOR FY 2008/2009

SN	UWSSA	Annual Production (Million M^3)	NRW (%)	Anual NRW in excess of 20% (million M^3)	Cost of Production per M^3	Cost of producing NRW (Million TSh)
1	Arusha	17.78	26.3	1.12	259.50	291
2	Babati	1.40	43.8	0.33	370.50	124
3	Bukoba	3.35	51.6	1.06	307.60	326
4	Dodoma	13.51	44.3	3.28	416.00	1,365
5	Iringa	5.73	42.0	1.26	438.30	553
6	Kigoma	6.54	34.1	0.92	174.00	160
7	Lindi	0.50	40.2	0.10	850.90	87
8	Mbeya	11.68	30.4	1.21	238.20	289
9	Morogoro	10.95	24.1	0.45	366.70	165
10	Moshi	10.45	32.5	1.31	282.00	368
11	Mtwara	3.31	27.4	0.25	693.30	170
12	Musoma	6.34	38.7	1.19	281.70	334
13	Mwanza	15.33	44.2	3.71	267.30	992
14	Shinyanga	4.78	36.4	0.78	348.60	273
15	Singida	2.09	35.1	0.32	249.80	79
16	Songea	4.35	39.8	0.86	352.80	304
17	Sumbawanga	0.80	44.0	0.19	163.80	31
18	Tabora	6.37	26.7	0.43	314.10	134
19	Tanga	9.90	24.6	0.46	326.00	148
20	Dar es Salaam	95.2	56.0	34.27	352.70	12,088
	Total	**230.36**				**18,281**

NB: Cost of production for DAWASCO has been assumed to equal to average production costs of other UWSSAs

APPENDIX 5: ESTIMATED VALUE OF NRW FOR FY 2008/2009

SN	UWSSA	Annual Production (Million M^3)	NRW (%)	Annual NRW in Excess of 20% (million M^3)	Average Tariffs per M^3	Price of Lost water (Million TSh)
1	Arusha	17.78	26.3	1.12	310.81	348
2	Babati	1.40	43.8	0.33	499.60	167
3	Bukoba	3.35	51.6	1.06	640.22	679
4	Dodoma	13.51	44.3	3.28	607.61	1,994
5	Iringa	5.73	42.0	1.26	624.26	787
6	Kigoma	6.54	34.1	0.92	229.95	212
7	Lindi	0.50	40.2	0.10	640.46	65
8	Mbeya	11.68	30.4	1.21	289.38	352
9	Morogoro	10.95	24.1	0.45	556.84	250
10	Moshi	10.45	32.5	1.31	347.87	455
11	Mtwara	3.31	27.4	0.25	624.26	153
12	Musoma	6.34	38.7	1.19	418.62	497
13	Mwanza	15.33	44.2	3.71	499.54	1,853
14	Shinyanga	4.78	36.4	0.78	409.93	321
15	Singida	2.09	35.1	0.32	373.01	118
16	Songea	4.35	39.8	0.86	525.37	452
17	Sumbawanga	0.80	44.0	0.19	306.63	59
18	Tabora	6.37	26.7	0.43	423.53	181
19	Tanga	9.90	24.6	0.46	441.48	201
20	Dar es Salaam	95.20	56.0	34.27	689.00	23,613
	Total	**230.36**		**53.50**		**32,756**

APPENDIX 6: ESTIMATED COST OF PRODUCING NRW FOR FY 2009/2010

SN	UWSSA	Annual Production (Million M^3)	NRW (%)	Anual NRW in Excess of 20% (million M^3)	Cost of Production per M^3	Cost of producing NRW (Million TSh)
1	Arusha	13.69	30.2	1.40	311.00	434
2	Babati	1.10	41.2	0.23	367.00	86
3	Bukoba	2.26	51.2	0.71	377.00	266
4	Dodoma	9.74	43.0	2.24	457.00	1,024
5	Iringa	4.09	35.2	0.62	465.00	289
6	Kigoma	3.30	58.0	1.25	290.00	364
7	Lindi	0.38	41.0	0.08	843.00	67
8	Mbeya	11.64	31.2	1.30	229.00	299
9	Morogoro	8.78	29.0	0.79	393.00	311
10	Moshi	8.64	29.0	0.78	317.00	246
11	Mtwara	1.71	22.0	0.03	617.00	21
12	Musoma	3.85	42.0	0.85	299.00	253
13	Mwanza	21.97	49.0	6.37	276.00	1,758
14	Shinyanga	3.69	23.8	0.14	525.00	74
15	Singida	1.60	34.0	0.22	411.00	92
16	Songea	2.34	29.0	0.21	318.00	67
17	Sumbawanga	2.19	42.1	0.48	204.00	99
18	Tabora	4.18	25.6	0.23	452.00	106
19	Tanga	10.28	25.0	0.51	411.00	211
20	Dar es Salaam	95.33	54.0	32.41	400.00	12,965
	Total	**210.76**				**19,031**

APPENDIX 7: ESTIMATED VALUE OF NRW FOR FY 2009/2010

SN	UWSSA	Annual Production (Million M^3)	NRW (%)	Annual NRW in Excess of 20% (million M^3)	Average Tariffs per M^3	Price of Lost water (Million TSh)
1	Arusha	13.69	30.2	1.40	351.80	491
2	Babati	1.10	41.2	0.23	452.20	105
3	Bukoba	2.26	51.2	0.71	605.30	427
4	Dodoma	9.74	43.0	2.24	594.00	1,331
5	Iringa	4.09	35.2	0.62	692.50	431
6	Kigoma	3.30	58.0	1.25	315.00	395
7	Lindi	0.38	41.0	0.08	735.70	59
8	Mbeya	11.64	31.2	1.30	344.00	448
9	Morogoro	8.78	29.0	0.79	500.00	395
10	Moshi	8.64	29.0	0.78	346.00	269
11	Mtwara	1.71	22.0	0.03	621.00	21
12	Musoma	3.85	42.0	0.85	452.40	383
13	Mwanza	21.97	49.0	6.37	514.00	3,275
14	Shinyanga	3.69	23.8	0.14	432.80	61
15	Singida	1.60	34.0	0.22	432.80	97
16	Songea	2.34	29.0	0.21	420.40	89
17	Sumbawanga	2.19	42.1	0.48	335.50	162
18	Tabora	4.18	25.6	0.23	499.00	117
19	Tanga	10.28	25.0	0.51	449.00	231
20	Dar es Salaam	95.33	54.0	32.41	720.90	23,366
	Total	**210.76**		**50.87**		**32,152**

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