

**INVESTIGATION OF NON-REVENUE WATER AND  
POTENTIAL ENERGY SAVING IN GREATER  
COLOMBO REGION**

Nalin Thewarapperuma

(08/8613)



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

Degree of Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

May 2013

**INVESTIGATION OF NON-REVENUE WATER AND  
POTENTIAL ENERGY SAVING IN GREATER  
COLOMBO REGION**

Nalin Thewarapperuma

(08/8613)



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

Thesis/Dissertation submitted in partial fulfillment of the requirements for the degree  
Master of Engineering

Department of Mechanical Engineering

University of Moratuwa

Sri Lanka

May 2013

## DECLARATION OF CANDIDATE AND SUPERVISOR

I declare that this is my own work and this dissertation does not incorporate without acknowledgment any material previously submitted for a Degree or Diploma in any other University or Institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgement is made in the text.

Also, I hereby grant to University of Moratuwa the non-exclusive right to reproduce and distribute my thesis/dissertation, in whole or in part in print, electronic or other medium. I retain the right to use this content in whole or part in future works (such as articles or books).



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

Signature:

Date:

The above candidate has carried out Research for the Masters under my Supervision.

Signature of Supervisor:

Date:

## Abstract

The main purpose of this study is to identify critical factors influencing high non-revenue water percentage which directly affects energy usage in greater Colombo region. It also addresses finding methods to minimize the percentage of non-revenue water. This study was carried out through a data analysis where the energy related data and quantities of water production data were collected from Ambathale water Treatment Plant. The NRW data was collected from relevant officers involved in distribution systems of National Water Supply and Drainage Board.

This study only covers the greater Colombo region (Colombo city limits). All other regions have issues related to non-revenue water in different levels. Therefore, generalization of this specific sector results for other provinces may have limitations.

Analysis of Colombo city region statistics shows that the water supply entity in Sri Lanka (National Water Supply and Drainage Board) is unable to reduce the Non Revenue Water percentage in Colombo city region which results in higher energy loss in the water supply system.

Necessary recommendations and suggestions are made for the implementation of programs to reduce non-revenue water percentage for a significant figure in greater Colombo region since this region has the highest NRW percentage in Sri Lanka. Improvement of service level to consumers, optimization of operational efficiency, reduction of production costs by reducing of specific energy consumption of water and institutional developments are some of the factors that can be achieved.

Facilitating access to safe drinking water for people has great impact on socio-economic development in Sri Lanka. Therefore, results of this study may help to develop a program to reduce non-revenue water percentage in greater Colombo region and thereby reduction of electrical energy usage, while ensuring the safe drinking water for higher percentage of the population living in greater Colombo region.

Keywords: Non Revenue Water, Specific energy consumption, Water treatment.

## ACKNOWLEDGEMENT

I am thankful to the University of Moratuwa for having offered me the opportunity to studying for the degree of Master of Engineering.

Without guidance, commitment and patience of Professor R.A. Athalage, Deputy Vice Chancellor University of Moratuwa, this dissertation would not have been realized. I wish to place on record my gratitude for him.

I am also thankful to Dr. A.G.T Sugathapala, who was the course coordinator and Dr. H.K.G.Punchihewa the present course coordinator for their support. NWSDB Higher management is gratefully remembered for the financial assistant granted and Deputy General Manager (Western Production) who is my immediate superior given me the flexibility for work to carry out my studies. I am grateful to all those who assisted me in this dissertation. My gratitude also goes to the staff of the Department of Mechanical Engineering.

I wish to record the undiminished encouragement from my wife, son and daughter throughout the preparation of this dissertation and for their support. I am grateful for all of them.



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)

N. Thewarapperuma

May 2013

## TABLE OF CONTENTS

Declaration of Candidate and Supervisor	i
Abstract	ii
Acknowledgement	iii
Table of Contents	iv
List of Figures	vi
List of Tables	vii
List of Abbreviations	viii
List of Appendices	ix
1. INTRODUCTION	1
1.1 Background of the Study	1
1.2 Identification of Problem	2
1.3 Objectives	4
1.4 Scope of Study	4
1.5 Methodology	5
1.6 Significance of the Study	6
1.7 Limitation of the Study	7
1.8 Chapter Outline	7
2. LITERATURE REVIEW	8
2.1 Introduction	8
2.2 Real Losses Performance Indicator	9
2.3 Real Losses or Physical Losses	12
2.4 NRW Levels Worldwide	13
2.5 Past Reports and Studies	15
2.5.1 Operations and system control study for the Greater Colombo Water Supply System (1987-1988)	15
2.5.2 Master Plan Update (1991)	15
2.5.3 Kalu Ganga Feasibility Study (JICA 1994)	16
2.5.4 Sri Lanka Third Water Supply and Sanitation Project (2000)	17
2.5.5 Detailed Design Study on Project for Reduction of NRW in the Greater Colombo Area (2001)	19

2.5.6	SAPROF Study 2007	21
2.5.7	Japanese Technical Cooperation for the Capacity Development Project for NRW Reduction in Colombo City	21
3	<b>METHODOLOGY</b>	23
3.1	Introduction	23
3.2	Conceptual Frame Work	23
3.3	Identification of the research area	23
3.4	Identification of Energy related and NRW related data to be collected	23
3.5	Method of Data Analysis	25
3.6	Summary	25
4	<b>RESULTS AND DISCUSSION</b>	26
4.1	Introduction	26
4.2	Ambatale water treatment plant	26
4.3	Analysis of NRW in Greater Colombo Region	29
5	<b>CONCLUSION &amp; RECOMMENDATION</b>	33
5.1	Introduction	33
5.2	Summary of Findings	33
5.3	Conclusion	33
5.4	Recommendations	34
5.5	Future Work	36
	Reference List	37
	Appendix A: New Intake Flow	39
	Appendix B: High lift Pumps	41
	Appendix C: Details of Reservoir and Transmission from Ambathale WTP	42
	Appendix D: Specific Energy – Ambathale WTP from 2008 - 2012	43
	Appendix F: Existing Power Arrangement of Raw Water Intake	57

## List of Figures

	Page
Figure 1.1 Monthly energy consumption in Ambatale WTP	3
Figure 1.2 Monthly Production Cost Ambatale WTP	4
Figure 1.3 Greater Colombo regions	5
Figure 2.1 Leak duration and volume	10
Figure 2.2 Run times of bursts on service pipes and mains	11
Figure 2.3 Key Influences on Annual Volume of Real Loss	12
Figure 4.1 Water balance for Colombo District	30
Figure 4.2 Chart of Colombo City Water balance and Value Cost	31



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)



## List of Tables

	Page
Table 2.1: Capital Investment Program of NWSDB (Rs. Billion)	8
Table 2.2: NRW as a share of water produced	13
Table 2.3: NRW in cubic meters per network length	14
Table 2.4: NRW Estimates and Values in Asia	15
Table 2.5: Unaccounted for Water in Existing Service	16
Table 2.6: Projected Water Loss Ratio in Kalu Ganga Feasibility Study (1994)	17
Table 2.7: Estimated Average NRW July 1999	17
Table 2.8: Distribution of Pipes - Material Wise - Colombo City	19
Table 2.9: Age-wise Distribution of CI Pipes in Colombo City	20
Table 2.10: Locations of Leakage Recorded in CI Pipes	20
Table 2.11: Target Water Loss Ratio/UFW in SAPROF Study	21
Table 3.1: Data Sources and Description of Data Acquired	24
Table 4.1: Intake and High lift Pump details	26
Table 4.2: Water production and Energy usage of High lift and Intake pumps	27
Table 4.3: Energy usage and pumping quantity at Maligakanda & Ellie house	28

## List of Abbreviations

Abbreviation	Description
ADB	Asian Development Bank
CBO	Community Based Organization
Cu. M.	Cubic Meter
GC	Greater Colombo
GOSL	Government of Sri Lanka
GWhr	Giga Watt hours
Km	Kilo Meter
LKR	Sri Lankan Rupee
Lpcd	Liter per Capita per Domestic
MDGs	Millennium Development Goals
MIS	Management Information System
NRW	Non-revenue Water
NWSDB	National Water Supply & Drainage Board
O & M	Operation & Maintenance
OIC	Officer In Charge
SEC	Specific Energy Consumption
SIV	System Input Volume
UN	United Nations
VSD	Variable Speed Drive
WTP	Water Treatment Plant



University of Moratuwa, Sri Lanka  
Electronic Theses & Dissertations  
www.lib.mrt.ac.lk

## List of Appendices

Appendix	Description	Page
Appendix A	New Intake Flow	39
Appendix B	Highlift Pumps	41
Appendix C	Details of Reservoir and Transmission from Ambathale WTP	42
Appendix D	Specific Energy – Ambathale WTP from 2008 - 2012	43
Appendix E	Monthly Pumping Statistics	45
Appendix F	Existing Power Arrangement of Raw Water Intake	57



University of Moratuwa, Sri Lanka.  
Electronic Theses & Dissertations  
[www.lib.mrt.ac.lk](http://www.lib.mrt.ac.lk)