

**UNIVERSITY OF NAIROBI**

**SCHOOL OF ENGINEERING**

**DEPARTMENT OF ENVIRONMENTAL AND BIOSYSTEMS ENGINEERING**

**FEB 540: ENGINEERING DESIGN PROJECT REPORT**

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**DESIGN OF WATER DISTRIBUTION SYSTEM THROUGH EPANET**

**CASE STUDY ARM, KALOLENI**

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**A Report Submitted in Partial Fulfillment for the Requirements of the Degree of Bachelor of Science in Environmental and Biosystems Engineering, the University of Nairobi**

**DECLARATION**

I declare that this project, except where specifically acknowledged, is my original work. This report has not been in whole or in part submitted for any degree or examination at any other University.

Caxton Kitonga Ngui-F21/1989/2013

Signature………………………. Date…………………………...

This project report has been submitted for examination with my approval as University Supervisor

Mr. Albert Kenyani Inima

Signature………………………. Date…………………………...

**DEDICATION**

I dedicate this Project to My Dad, Mr. Stephen Kinyilli, Mum, Mrs. Rhoda Wairimu, My brothers, Clinton, Ken, and Eric and to all my dear friends for their constant prayers and emotional support.

You all inspired me and gave me the strength to do this project to completion

**ACKNOWLEDGEMENT**

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This design project report would not have been realized without the support of my family, whose love and encouragement has always given me the confidence to believe in my own abilities and for the financial support in the development of this report. This design project report is dedicated to them.

***To all those who contributed, my deepest gratitude***

**ABSTRACT**

Water is the source of life for every living organism worldwide. In Kenya, the available water resources are diminishing at an alarming rate with an estimate that by the year 2025, the renewable fresh water supply will have decreased to 235m3 per capita per annum as compared to now which is 650m3 per capita per annum (Biamah & Njeru, 2010). There is a reason to protect these existing resources as much as possible for the future generation.

This project is studying the issues of lack of water at the residents of ARM PLC, Kaloleni, identifies the possible causes of the water shortage problem and then designing an effective water distribution system through EPANET. A water distribution system is a sort of hydraulic infrastructure made up of pipes, tanks, pumps, and valves. It is crucial to provide safe drinking water to individuals, in the right quantity and at the required time. This calls for the design of an effective water distribution network or if there was an already existing water supply system, it is paramount to make more reliable and effective. Many companies or plants have water distribution system but very few among them are aware of the water pressures within the pipes, the peak hour water demands and how to monitor a water contaminating agent incase such a scenario happens.

The water distribution design system will be through EPANET based at Athi River Mining, Kaloleni plant focusing at the employee premises and as well the water used by workers at their different work stations.

**LIST OF ABBREVIATIONS**

**ARM-**Athi River Mining

**WDNs-**Water Distribution Networks

**NOAA-**National Oceanic and Atmospheric Administration

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LIST OF SYMBOLS

A - Area

Cω - Coefficient of Discharge.

Cr - Runoff Coefficient.

e - Exponential

Ep - Pump Efficiency

g - Acceleration due to gravity

KW - Kilo-Watt

KWh - Kilo-Watt hour L - Length

m - Meters

M³/sec. - Cubic meters per Second.

n - Manning

Pp - Pump Power Requirement

Q - Discharge

S - Slope

Tc - Time of Concentration

V - Velocity

𝛴 - Summation

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# 1.0 Introduction

## 1.1 Background Information

Looking back at history, the practice of water transportation for human consumption has been in existence for millennia. From the first pipes in Crete some 3,500 years ago to today’s complex hydraulic models, the history of water distribution technology is quite a story. Water distribution systems (WDNs) have served to serve various purposes in the human history in addition to the provision of water for human use, which approximately accounts for less than 3% of the total volume of water supplied (Arnalich, 2011). Piped water has various uses including sanitation, irrigation, firefighting, and washing. Usually, networks are designed in order to meet peak demands; in parts of such network, a low flow situation is created contributing to the deterioration of microorganism and chemical quality of water.

Pipe system serves to supply water at adequate pressure heads. However, the intended pressure is not always achieved because of friction forces between the water and the pipe walls. This pressure loss effect is also dependent on the pipe length, gradient, pipe diameter and water demand. Many empirical equations have been established to describe water pressure-flow relations (Webber, 1971) and these relationships have been incorporated into water modeling software packages to facilitate their efficient usage and solution provision. To date, there is still no convenient evaluation of water distribution systems reliability. Traditionally, any water distribution design system is based on the plan of the proposed street and the slope of the land. By use of the available commercial software, the modeler stimulates pressures and flows in the network and flows in and out of the tanks for essential loadings.

Water distribution networks have a major role that they play in the modern societies since their mode of operation is related directly to people well-being. Water supply activities, however, tend to be somewhat natural monopolies, hence to guarantee providence of good services in sustainable ways, the water distribution system performance has to be evaluated. The inclusion of performance assessment methods in management practice produces competition leading to a culture of efficiency and pursuit of unending improvement. Water utilities have the primary duty of ensuring that the required water quantity to specific customers under the necessary pressures is delivered through a distribution system.

Drinking water distribution through the distribution systems is a technical challenge both quantitatively and qualitatively. This means that every point of the network has an invariable water flow complying with all the quantitative and qualitative parameters. Water supply in Athi River Cement plant specifically within the residence premise is usually available for few hours, sometimes dirty and one end up having to wait for some time before clean water starts flowing out. This leads to wastage of the scarce water. The flow outs are usually of very low pressure and it’s unpredictable. These problems impose financial costs on the employees because they have to buy water from the nearby borehole water sellers as well as health costs.

Fig. 1.4 a picture of water situation at Kilifi CountyC:\Users\user\Desktop\iamge 4.tif

Source: Daily Nation, June 6, 2016

## According to this post by the Daily Nation, Mombasa, Kilifi, and Kwale counties are facing a water crisis situation. A statistical analysis from the Daily print indicated that Mombasa receives only 48 million Litters of water a day from its neighbors against its demand of 200 million litters a day. This result in a deficit of 152 million liters of water a day hence the little amount that is available needs to be used efficiently and effectively. This water shortage is attributed to the county’s lack of fresh water sources forcing them to depend solely on piped water supply.