Vaal University of Technology

MONITORING AND MODELLING OF WATER QUALITY CHARACTERISTICS ALONG A RETICULATION SYSTEM: A CASE STUDY OF MODIMOLLE RETICULATION NETWORK

by

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Declaration

I declare that this dissertation is my own unaided work, except where specific acknowledgement is made in the form of a reference. The dissertation is being submitted for the degree of Magister Technologiae: Civil Engineering at the Vaal University of Technology, Vanderbijlpark. It has not been submitted before for any examination.

MAHLOMOLA MEHLO

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CERTIFICATION

We have read this report and approve it for examination

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Dedication

This work is dedicated to my former colleague and friend, Tsietsi Moganetsi, who passed away during September 2011. Mr Moganetsi was a Laboratory Technician at Magalies Water and he assisted me greatly with the testing of the samples for this study. May his soul rest in peace.

Abstract

Potable water quality can deteriorate immensely from point of treatment to point of usage. This change in quality along a bulk distribution main may be attributed to numerous factors, such as the ingress of storm water. Furthermore, water utilities experience challenges in terms of the microbiological organisms that are not attributed to operational practices. For example, drinking water bulk distribution mains may be a shelter for these microorganisms that are sustained by organic and inorganic nutrients present within the pipe itself. These microorganisms may be active in the water being transported by the pipe, and can cause a significant drop in the water quality. In order to deal with the problem of deteriorating water quality, sufficient information within the bulk main is required, so that the consumer can be protected from ingesting contaminated water or water of poor quality. Hence, the overall objective of this study was to investigate and model water quality characteristics within the Modimolle reticulation network.

Water samples were collected from various points throughout the entire system for quality analysis. Different sampling points were established along the main pipeline as well as within the Modimolle distribution system. Water quality software, EPANET, was then used to model the water quality deterioration for both the bulk line and the reticulation network of Modimolle extension 11. Residual chlorine was the main parameter which was monitored. This study presents results of a research on water quality variation within a long distribution mains conveying water up to 87 km. Results show that raw residual chlorine is constantly depleted along the pipeline, and is therefore unable to be maintained at the required level of 0.2 mg/l, as stipulated by the Department of Water Affairs. This means that if any harmful contaminants should enter the water, the residual chlorine in the water will not be able to protect the consumers from the contaminants.

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NOMENCLATURE, TERMS AND CONCEPTS

Nomenclature

$CaCO_3$ – Calcium Carbonate
BOD - Biological Oxygen Demand
DAFF - Dissolved air flotation filtration
DWEA – Department of Water and Environmental Affairs
EPANET – Software used to model water networks
GIS - Geographic Information System
IMQS - Infrastructure Query Management System
km - kilometres
mg/ℓ - milligrams per liter
Mℓ/d – Mega liters per day
MPN - Most probable number
SANS – South African National Standards
TDS - Total Dissolved Solids
WHO – World Health Organization
WSA – Water Service Authority
WTP - Water Treatment Plant

Terms and Concepts

Escherichia coli (E-coli) – Used as indicators to test for the presence of microorganisms for pathogens that may be present in feces.
Fecal Coli forms – Used as an indicator of fecal contamination
Hard Water - Hard water is water that has high mineral content, particularly calcium and magnesium ions.
Soft Water – Soft water would therefore be water that has less or no mineral content, particularly calcium and magnesium ions.
Scum - Foam like substance which is formed when water saturated with air lifts the solids above the top surface of the saturated water.