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EFFICACY AND EFFICIENCY OF LAGOON WASTEWATER TREATMENT AND THE EFFLUENT QUALITY WITH FOCUS ON BIOLOGICAL INDICATORS AT BARATON COMMUNITY, NANDI COUNTY, KENYA.

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Abstract

Lagoon waste-water system is one of the wastewater treatment methods mostly used in semi-urban areas due to its low cost of establishment and high purification qualities (Steinmann. C., Weinhart. S., & Melzer. A., 2003). When a lagoon waste-water treatment system is properly constructed and used; the system is effective in eliminating any contaminants and pollutants in the waste-water. Poor sitting, construction and use of a lagoon waste-water treatment system poses a grave danger of pollution to the environment (EPA, 2011). The independent variable is the standard total coliform count the dependent variable is the observed total coliform count in MPN per ml. An observational descriptive cross-sectional study design was used to conduct this research. Data was collected using an observational checklist. Bacterial waste-water analysis of the waste-water was carried out in a microbiology lab and the results recorded in a wastewater sampling form. Following the descriptive analysis of the data it was observed that the total coliform count remain stagnant at 11.547MPN/ml from inlet until the last stage of treatment in this system which is the tertiary pond where there is a drastic 25% drop in total coliform count to 4.082MPN/ml. it is expected that the ponds maintain a maximum MPN/ml total coliform count of 10MPN/ml throughout the ponds during treatment and the total coliform count of the final effluent should be at a maximum of 4MPN/ml. There is a significant difference between the observed total coliform count and the expected total coliform count at a p value of 0.046 which is significant at p=0.05. In conclusion, there is increased coliform count within the ponds as observed compared to the expected coliform count at each pond hence non efficient and effective operation of the baraton lagoon waste-water treatment plant. It is recommended that the structural standards like proper construction of the ponds as well as the operational standards like controlled retention time achieved through improved standard structures of the research facility to be effected so as to optimize efficiency and efficacy of the system.

Keywords: Efficacy, Efficiency, lagoon, Waste-Water, Biological Indicators

INTRODUCTION

Waste-water is one of the leading environmental polluters. Lagoon waste-water treatment is one of waste-water treatment methods mostly used in semi-urban areas due to its low cost of establishment and high purification qualities (Steinmann. C., Weinhart. S., & Melzer. A., 2003). When properly constructed and used lagoon waste-water treatment is effective in eliminating any contaminants and pollutants in the water to the environment. Poor construction, use and sitting of lagoon waste-water treatment poses a grave danger of pollution to the environment.

Lagoon method of wastewater treatment is a process through which waste water is received into ponds referred to as lagoons from the sewage lines. In most cases, there are either two or three lagoons. Waste water is then retained at each lagoon for a recommended amount of time and the final effluent from the final treatment lagoon is released into a wetland or a water body, if it meets the required total coliform count standards for release (EPA, 2011).

PROBLEM STATEMENT

Multifunctional wastewater lagoon systems are designed to treat and manage sewage and wastewater through natural processes. However, many such systems face significant operational challenges that undermine their effectiveness. These challenges include inadequate design features, such as insufficient pond capacity, lack of appropriate liners, and absence of essential components like maturation ponds. The University of Eastern Africa, Baraton community lagoon wastewater treatment facility, which currently operates with three functional ponds: primary, secondary and tertiary faces challenges emanating from design concerns such as lack of a fourth pond (maturation pond) among others that have over the past attracted complaints from the community. This multifaceted problem necessitates a comprehensive evaluation of the design operation, and management of wastewater lagoon systems using microbial count as a quality indicator of design efficacy. Addressing these issues is critical for safeguarding water quality, protecting public health, and ensuring sustainable wastewater management in Baraton community which is experiencing rapid population growth.

OBJECTIVE

To determine the efficiency and efficacy of lagoon wastewater treatment system in microbial reduction of the effluent.

MATERIALS AND METHODS

Study design

Descriptive-cross sectional study design was used to conduct this research. The characteristics of the representative lagoon wastewater treatment system were observed cross-sectional to capture the aspects of each stage in the system.

Research site

The lagoon wastewater treatment system of interest is situated in the University of Eastern Africa, Baraton Community. The facility serves an approximate population of 4000 people daily. It is the main wastewater treatment method available in this community and has been in service for decades. It operates with three functional ponds that is: primary treatment pond, secondary treatment pond and tertiary treatment pond. The facility also has a preliminary treatment section that contains screens which remove the large suspended materials form the waste water.

Sampling

Grab sampling method was used to collect samples from each pond. Grab sampling is done manually and the samples submitted to the lab for

analysis (Washington conservation district monitoring program, 2007). EPA 2017, wastewater sampling manual was used guide the sampling procedure which states that in relation to grab sampling the individual samples should not be collected more than fifteen minutes apart.

Sample analysis and data collection

The collected samples were analyzed in the lab by using the bacteriological analysis of water procedure originally compiled by John Klock in 1971 to determine the presence of coliforms at each stage of treatment as well as quantify the microbial load using the most probable number per milliliter of waste-water and recorded in a waste-water sampling form. Additional data was collected by using an observational checklist to record observed standards and conditions of the lagoon waste-water treatment system at Baraton community.

Data management

The observations from the bacteriological analysis of samples and the data from the checklist were processed using the SPSS version 25 software to determine the microbial load at each stage of the system and Chi-square test was carried out to observe the possible difference between the expected total coliform count and the observed total coliform count.

Ethical considerations

The proposal was submitted for approval at the University Of Eastern Africa, Baraton research ethics committee for approval. The University management also permitted the conduct of this study at the facility.

RESULTS AND DISCUSSION

The bacterial analysis conducted on the waste water samples revealed that indeed coliforms were present. The coliform load which is the microbial load at inlet is 11.547mpn/ml which remains constant through the primary and the secondary pond meaning the treatment is not effective in this ponds. There is a significant 25% drop in coliform count in the tertiary pond to a coliform count of 4.082mpn/ml. The expected maximum coliform count of each pond should be at 10mpn/ml and the final effluent expected coliform standards should be at 4mpn/ml**,** Owusu-Ansah,et al, (2015). There is a significant difference between the standard expected effluent and the effluent recorded from the Baraton lagoon wastewater treatment plant which is significant at a p value of 0.046 which is less than p=0.05 significance level.

Table

Table 1: total coliform count expected and observed at Baraton lagoon waste water treatment system and chi-square significant test

Source of sample	*Expected coliform count* *Mpn/ml*	*Observed coliform count* *Mpn/ml*	*Sig. in difference*	*Degree of freedom (df)*
Inlet	10	11.547		
Primary pond	10	11.547		
Secondary pond	10	11.547		

Tertiary pond	4	4.082	1
		X^2= 1.72	
	P=0.046: 95% CI		

CONCLUSION AND RECOMMENDATIONS

There is increased coliform count within the ponds as observed compared to the expected coliform count at each pond hence non efficient and effective operation of the baraton lagoon waste water treatment plant. To effectively handle the increasing sewage levels and maintain efficient operations, the Baraton community lagoon wastewater treatment facility should address its design limitations and invest in necessary upgrades. Proactive measures will not only protect community health and the environment but also enhance the facility's resilience in the face of growing demands.

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