Annual Academic Sessions 2011
ISSN 2012-9912; ©2011 Open University of Sri Lanka

DEVELOPMENT OF WASTEWATER PURIFICATION MODEL WITH BIOTOPE FOR A POLLUTED STREAM AT OUSL

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INTRODUCTION

Nutrient enrichment of natural water system due to wastewater disposal is a critical issue in Sri Lanka. The Diyawanna Oya water system which consists of Kirulapone Canal is an important water source. However it is getting polluted due to haphazard wastewater disposal methods of surrounding community. One of the streams, which connects to Kirulapone Canal, flows across the OUSL premises, gives unpleasant image to the OUSL, as it carries wastewater of nearby community. Therefore it is decided to purify this wastewater to acceptable quality by using natural environment functions before it flows into the Kirulapone Canal while preparing a pleasant aesthetic view to the OUSL. This research was carried out to introduce Bio Geo Filter (BGF) and Biotope on the stream bed and at the embankments respectively as solutions.

Figure 1-Wastewater inlet to OUSL stream

The BGF contains three main components such as, an impermeably clay layer at the bottom, a gravel media which helps for filtration and provide nutrients and supports for root zone and the vegetation zone above the surface which absorbs various pollutants from the waste water (Jayasekara, 2008). Biotope is an area of uniform environmental conditions providing a living place for a specific assemblage of plants and animals.

The stream involved in this study is located in between the Media House and Exam Hall-03 at The Open University of Sri Lanka, Nawala, Nugegoda. The approximate length of the stream in the University premises is 82 meters and the entire length is to be used for this research. The water flows in the stream is contaminated with various pollutants. The color of the water also shows an unpleasant view as shown in figure 1.

METHODOLOGY

Water quality parameters such as Phosphate, Nitrate, Ammonia, COD, pH, Total Dissolved Solids (TDS), Salinity and Conductivity of the wastewater were tested. Phosphate, Nitrate and Ammonia are tested using Spectrophotometer while pH, Total Dissolved Solids (TDS), Salinity and Conductivity were obtained using pH meter. The COD test was carried out by Open Reflux Method. The maximum and minimum discharge of wastewater in the stream was measured in wet and dry seasons respectively using Current Meter named "Electromagnetic Flow Meter 801".

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The leveling survey was carried out to find the gradient of the stream and the topographical features of the area where the Treatment Unit is to be constructed. A Longitudinal Section of stream and the Cross Section at 4m chainage where the Dam is to be constructed are drawn.

The Geotechnical Investigation was carried out to identify the soil condition of the area. A test result of a borehole near this area is used for this process. This borehole test was done in the year 2001 for the construction of Exam Hall-03. The types, thickness, SPTN values, etc. of soil layers are taken into consideration in this investigation.

The most efficient, economical and environmental friendly design was done to suit the topographical condition and flow rate and pollutant concentration of water by using the design concepts of Free Water Surface (FWS) Constructed Wetlands. The length and the width and the number of cells and the depth of water were designed accordingly. The suitable plants for the BGF and Biotope were identified considering condition of the stream and the efficiency of pollutant removal of the plant species

RESULTS AND DISCUSSION

The study was targeted to treat the wastewater flowing through the stream by following the concept of self purification capacity. Water quality parameters were measured when the stream run with minimum flow in dry season and maximum flow that is flooded conditions at rainy season. the concentrations of pollutants were high in dry season. The water quality parameters of the stream in selected dates are given in Table 1.

Water Quality parameters	Date			
	8/2/2010	17/2/2010	23/2/2010	5/5/2010
Conductivity (µs/cm)	628	528	687	467
Salinity (g/l)	0.5	0.5	0.5	0.5
TDS (mg/l)	374	319	413	280
Nitrate (mg/l)	0	0	0	0
Ammonia (mg/l)	9.6	7.3	17.1	2
Phosphate (mg/l)	5.7	4	8.9	0.9
pH	6.73	6.93	7.17	6.6

Table 1 Water Quality parameters of the stream

The maximum measured discharge of the stream is 185.6 l/s and the minimum was 10.5 l/s. The COD values of the upstream and the downstream of the stream are 57.96 mg/l and 38.64 mg/l respectively.

The daily rainfall intensity variation in Colombo for the year 2010 with the dates of tests carried out for the water quality parameters is shown in figure-2 while concentrations of the major pollutants in the wastewater of the stream is shown in figure-3. The results shows that Phosphate level was higher than the permissible level provided by the Central Environmental Authority. Phosphate is one of the pollutants causes for nutrient enrichment and hence, this indicates that the wastewater of the stream must be purified. Moreover since the pollutant concentration of the wastewater was high only during dry season, and therefore the proposed Treatment System is designed by focusing the dry season flow. Nevertheless more attention is made in the design on the stability of the system for the wet season when the water flow is high or similar situation like flooding.

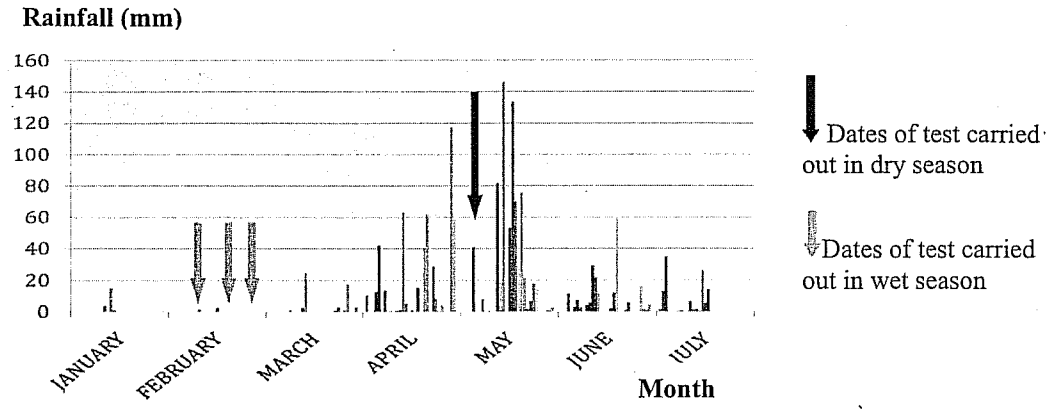

Figure 2-Daily rainfall intensity variation in Colombo for the year 2010

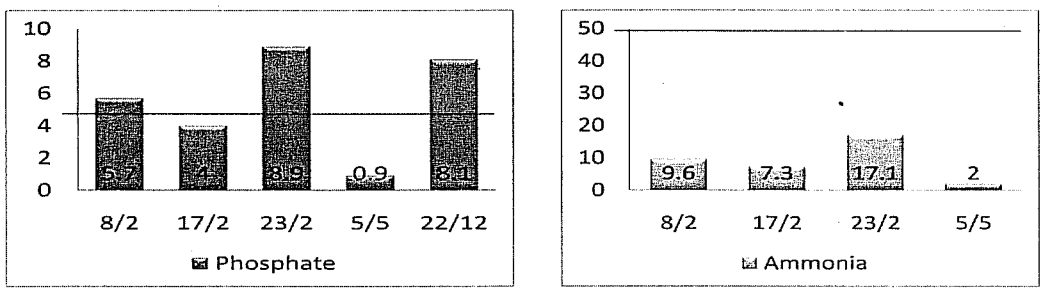

Figure 3-Concentrations of major pollutants and the permissible level of wastewater

(Permissible level of 5mg/l for phosphate and 50mg/l for ammonia are shown in continuous line)

This study suggests a suitable and economical solution for the stream pollution by natural wastewater treatment method using Bio-Geo Filter. Analysis reveals that some of the pollutants levels of the stream are higher than the permissible levels. Therefore the stream water needed to purify before entering to the Kirulapone canal. The treatment system consists of three components namely, the Treatment Unit (retention pond), Bio Geo Filter (BGF) and the Polishing Pond. The initial treatment is done in the Treatment Unit and further treatment is done in the BGF and finally the treated water is allowed to flow through the Polishing Pond where the condition of the treated water is visualized. The layout of the purification system is shown in Figure-4.

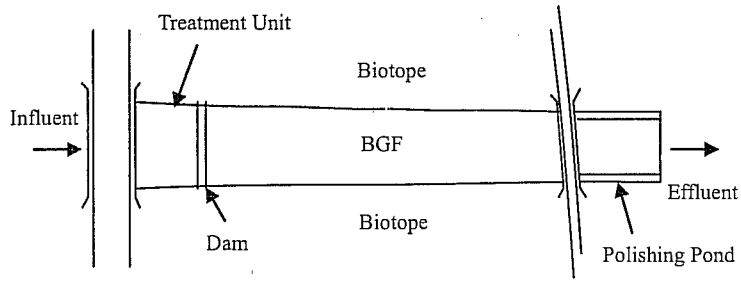

Figure 4-Layout of the proposed purification system

This Treatment Unit or retention pond is the first component of the proposed treatment system and to be constructed at the upstream of the stream. The second component name as BGF is designed for further treatment of the wastewater flows out from the Treatment Unit which is subjected to the initial treatment.

Suitable plants which are to be planted in the BGF were identified. The plants for Biotope were identified and initial planting for Biotope was carried out. The third and the final component of the system named as the Polishing Pond is to be constructed at the downstream to visualize the condition of the treated water before enter to the Kirulapone Canal.

The design of the proposed treatment unit involved Hydraulic, Geotechnical and Structural design. Based on the hydraulic design the capacity of the treatment unit to be extended up to 15 m^3. Since the average flow rate in dry season is 10.5 l/s, the retention time of the treatment unit is limited for 25minutes. The BGF was designed with three steps between the Treatment Unit and the Polishing Pond. Laterite stone (Kabook) are to be used as the filter media or bed material (Jayasekara, 2008; Cafferia *et al*, 1996) and *Gal ehi pan, Thun hiriya pan,* and *Havan pan* are to be planted in the BGF. More than 20 varieties of plants are to be planted for the establishment of Biotope on the embankments. Figure 5 shows the pictorial view of Biotope at the Central Campus of OUSL. According to the collected data and the results, this natural purification system possibly reduce the pollutant concentration lower than the permissible level.

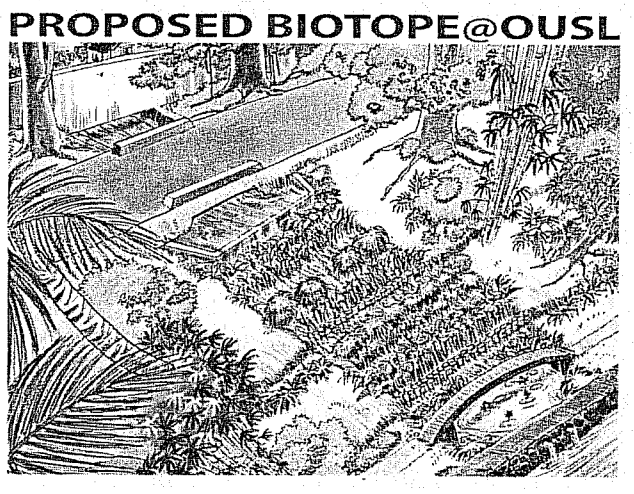

Figure 5- Pictorial view of proposed Biotope

CONCLUSIONS

This study reveals that level of Phosphate concentrations in the stream is 8.9mg/l, which is considerably higher than the permissible level stipulated by Central Environmental Authority. Therefore, Bio Geo Filter (BGF) with laterite stone *"Kabook"* on the stream bed has to be employed to reduce phosphate levels of wastewater and variety of plant to be planted at embankments for establishment of Biotope.

ACKNOWLEDGEMENT

The authors express their gratitude to Dr P.N Wikramanayake, Dr UKGK Padmalal for their guidance; Mr T. Senevirathna, Ms Chanuka Kumari, Environmental Studies Unit for kind help on establishing biotope and Ms Pradeepa Rajaguru, Department of Civil Engineering, OUSL for assisting experimental works.

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