International Journal of Trend in Scientific Research and Development (IJTSRD)
Volume 3 Issue 5, August 2019 Available Online: www.ijtsrd.com e-ISSN: 2456 – 6470

Water Pollution Control for Mandalay KanDawGyi Lake by Natural Treatment System

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How to cite this paper: Moh Moh | San San Myint "Water Pollution Control for Mandalay KanDawGyi Lake by Natural Treatment System" Published in International Journal of Trend in Scientific Research and Development (ijtsrd), ISSN: 2456-6470, Volume-3 | Issue-5, August 2019, pp.390-393, **https://doi.org/10.31142/ijtsrd25323**

IJTSRD25323

ABSTRACT
This paper emphasized on "Water Pollution Control for Mandalay KanDawGyi Lake by Natural Treatment System". KanDawGyi Lake is used for wastewater collection. It is situated in ChanMyaThaZi Township, Mandalay and near the AyeYarWaddy river. Residential, commercial and industrial area are existed surrounding the KanDawGyi Lake. Water from human activities such as cooking, bathing, washing and septic tanks effluent is discharged into drains by gravity flow without treatment. Average six million gallons of wastewater discharged from Mandalay City area flow into KanDawGyi Lake passing through ThinGaZar creek daily. So, lake water has been contaminated by domestic wastewater. This has resulted detrimental effects on the ecosystem. Water in recreation center should be aesthetically pleasing and essentially free of toxicants and pathogenic organisms. Seven collection points such as entrance, east of north side, south-east of north side, south of north side, water fountains, PyiGyiMon barge and exit of KanDawGyi Lake are chosen to collect the wastewater sample. The water quality of KanDawGyi Lake is evaluated by various parameters such as temperature, turbidity, suspended solids, dissolved solids, pH, total alkalinity, total hardness, biochemical oxygen demand, dissolved oxygen, chlorides, total solids and bacteria. According to test results, alkalinity, chlorides, dissolved solids, suspended solids, and total solids are uncertified. Therefore, in this paper wetland design of natural treatment system is used at the entrance of the lake to control the water pollution.

KEYWORDS: *Water pollution, Lake, Wetland*

I. INTRODUCTION

Water pollution can be defined in many ways. Usually, it means one or more substances have built up in water to such an extent that they cause problems for animals or people. Oceans, lakes, rivers and other inland waters can naturally clean up a certain amount of pollution by dispersing it harmlessly. When clean water is essential for all on earth, water pollution has always been a major problem throughout the world. At present time, as growth rate of population accelerates, usages of water are more. The more water consumption, the more wastewater is discharged. These vast quantities of untreated domestic wastewater flow into drains leading to streams, lakes or rivers. So, water system has become severely polluted.

The discharge of raw wastewater into the aquatic environment may cause serious damages to many forms of life as a result of oxygen depletion in the receiving water bodies. Additionally, this discharge poses a potential risk for the transmission of a large number of water related diseases.

The unsound development, economic growth, the environmental pollution and ecological degradation is more and more serious. It is mainly reflected in the regional water pollution from domestic and industrial wastewater discharge and threatens to the biodiversity.

II. INFORMATION OF KANDAWGYI LAKE AND SAMPLING

KanDawGyi Lake is used for wastewater collection. It is situated in ChanMyaThaZi Township, Mandalay. It is near AyeYarWaddy river. KanDawGyi Lake is about 1831.62 acres composing of 616.22 acres of land areas and 470.99 acres of water surface areas in the south side and 470 acres of land areas and 274.41 acres of water surface areas in the north side. Nowadays, KanDawGyi Lake will be created as recreation center. There is a PyiGyiMon Barge, three water-fountains, garden with playgrounds and places for sight-seeing as relaxation. The sampling techniques used in wastewater survey must ensure that representative samples are obtained, because the data from the analysis of the samples will ultimately serve as a basic for designing treatment facilities. Seven collection points are chosen for sampling as shown in Figure 1. The sample collected for analysis should be a true representative of the water quality of the source collection and small enough in volume to be transported conveniently and handled in the laboratory.

Figure1. Sample Collection Points in KanDawGyi Lake

III. EVALUATION OF LAKE WATER QUALITY

Water in lake may be purified to some extent due to storage, but may still contain colloidal matter and bacteria. Those impurities need to be reduced to tolerable limits before discharging into river. Important water quality parameters relating to wastewater discharges are biochemical oxygen demand (BOD), dissolved oxygen (DO), suspended solids, coliform bacteria, ammonia, pH and toxic chemicals.

A. Testing of Wastewater Sample

Collected wastewater samples are tested in Environmental Engineering Laboratory of Mandalay Technological University and Public Health Laboratory, Mandalay. The parameters of wastewater quality of temperature, turbidity, suspended solids, dissolved solids, pH, total alkalinity, total hardness, biochemical oxygen demand, dissolved oxygen, chlorides, total solids and bacteria are tested.

B. Test Results

All tests are performed in accordance with the standard procedures and the test results are shown in the following Figures.

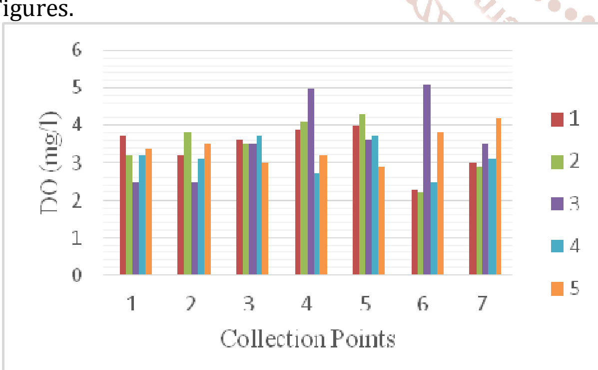

FIGURE2. TEST RESULTS FOR DO

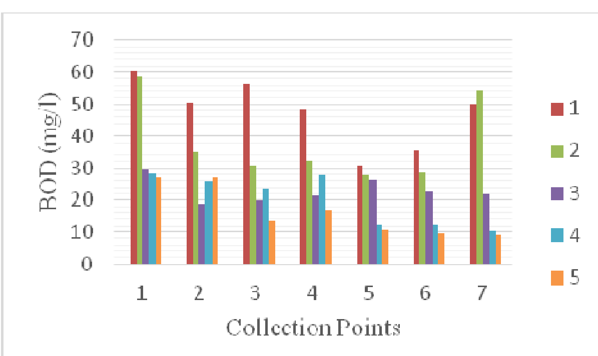

FIGURE3. TEST RESULTS FOR BOD

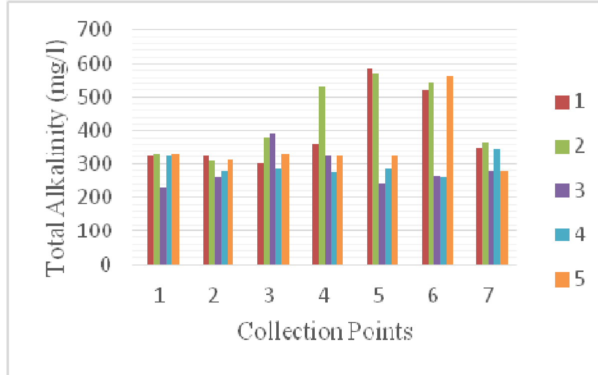

FIGURE4. TEST RESULTS FOR TOTAL ALKALINITY

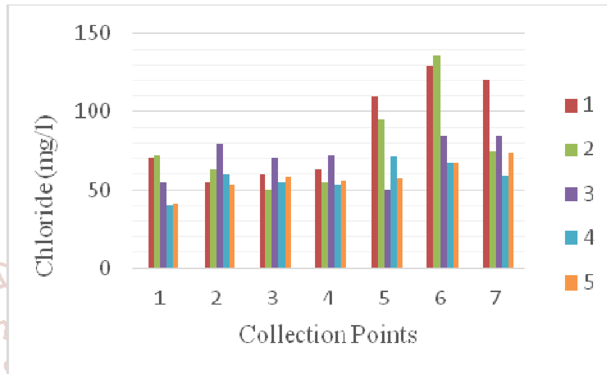

FIGURE5. TEST RESULTS FOR CHLORIDE

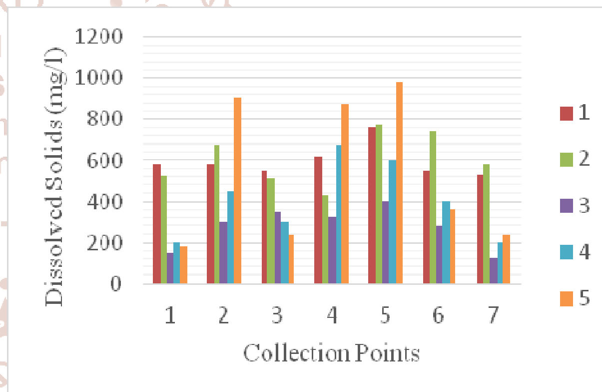

FIGURE6. TEST RESULTS FOR DISSOLVED SOLIDS

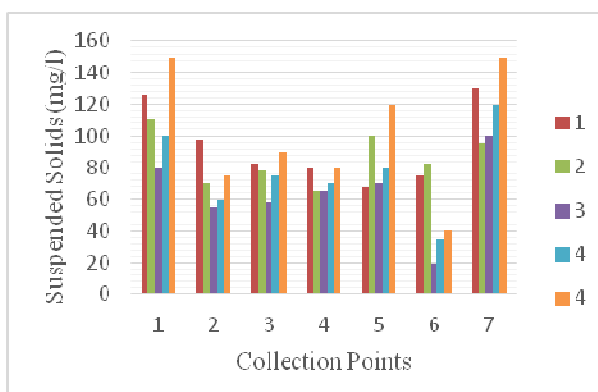

FIGURE7. TEST RESULTS FOR SUSPENDED SOLIDS

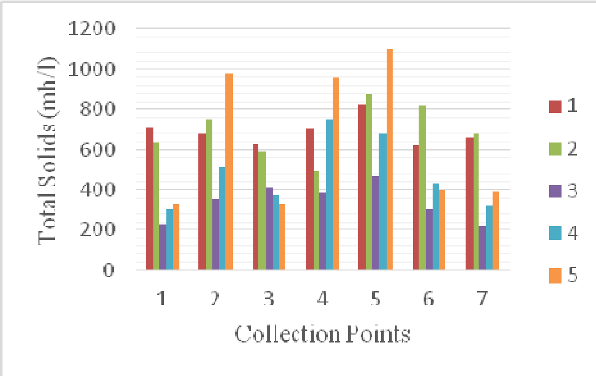

FIGURE8. TEST RESULTS FOR TOTAL SOLIDS

IV. DESIGN OF NATURAL TREATMENT SYSTEM

The natural treatment systems include (1) soil-based or land treatment systems-slow rate, rapid infiltration, and overland flow and (2) the aquatic-based systems –constructed and natural wetlands and aquatic plant treatment systems. In this paper, Aquatic based system is used as natural treatment system to control the water pollution for KanDawGyi Lake.

A. Aquatic Plant System

In aquatic plant systems, free floating growths are harnessed for wastewater treatment such as hyacinths and duckweeds. The aquatic plants are capable of transporting air (oxygen) from the atmosphere to the roots where a part diffuses into the liquid substrata. For KanDawGyi Lake, water hyacinths are used to purify municipal and industrial wastewater in secondary treatment to effluents from algal waste stabilization ponds or aerated lagoons. By planting the water hyacinths, the capacity for nitrogen can be removed about 1 g/day/ m^2 pond area and also phosphorous of about 0.25 g/day/ m^2 pond area can be removed. The planting of water hyacinths in this lake is shown in Figure 9.

FIGURE9. PLANTING OF WATER HYACINTHS

B. Aquaculture System

Aquaculture is the growth of fish and other aquatic organisms for the production of food sources. Wastewater has been used in a variety of aquaculture operations around the world. Most of the treatment achieved in aquaculture systems has been attributed to the bacteria attached to floating aquatic plants. There is little evidence that fish contribute directly to treatment. To balance the ecosystem of the lake and to control the water pollution, fish production pond is created in this lake. Although natural carrying capacities in this lake are greatly exceeded, an artificial ecology is established among the various organisms and the environment in which they live. Figure 10 shows creation of fish production pond.

FIGURE10. CREATION OF FISH PRODUCTION POND

V. DESIGN OF WETLAND SYSTEM

Wetlands are inundated land areas with water depths typically less than 2 ft (0.6 m) that support the growth of emergent plants such as cattail, bulrush, reeds and sedges and seasonal vegetation. The vegetation provides surfaces for the attachment of bacteria films, aids in the filtration and adsorption of wastewater constituents, transfers oxygen into the water column, and controls the growth of algae by restricting the penetration of sunlight. Both natural and constructed wetlands have been used for wastewater treatment, although the use of natural wetlands is generally limited to the polishing or further treatment of secondary or advanced treated effluent. Constructed wetlands are those which are man- made either for the purpose of impoundments of specific value to wildlife/ecosystem or for treatment of wastewater, storm drainage, etc. Two types of constructed wetland systems have been developed for wastewater treatment: (1) free water surface (FWS) systems and (2) subsurface flow systems (SFS). The principal design parameters for constructed wetland systems include hydraulic detention time, basin depth, basin geometry (width and length), BOD_5 loading rate, and hydraulic-loading rate. Typical ranges suggested for design are given in Table I.

Table I. DESIGN GUIDELINES FOR CONSTRUCTED WETLANDS

Design parameter	Unit	Type of system	
		FWS	SFS
Hydraulic detention time	d	4-15	4-15
Water depth	ft	0.3-2.0	1.0-2.5
BOD_5 loading rate	lb/ acre.d	< 60	< 60
Hydraulic loading rate	Mgal/acre.d	0.015-.05	0.015-0.05
Specific area	acre/(Mgal/d)	67-20	67-20

A. Design of FWS Wetland System

Wetland system provides a valuable addition to the green space in a community, and includes the incorporation of wild life habitat and public recreational opportunities. Wetland system produces no residual biosolids or sludges requiring subsequent treatment and disposal.

1. Determination of hydraulic detention-time (t) using first order removal model.

$$\frac{C_e}{C_o} = A\exp\left(-0.7k_T (A_v)^{1.75} t\right) \quad \text{Equation 1}$$

2. Determination of surface area (LxW)

$$t = \frac{LWnd}{Q} \quad \text{Equation 2}$$

3. Checking hydraulic loading rate (Lw) or specific area (Asp)

$$A_{sp} = \frac{1}{L_W} \quad \text{Equation 3}$$

4. Checking BOD5 loading rate (LBOD5)

$$LBOD_5 = \frac{QC_O}{LW} \quad \text{Equation 4}$$

B. Design of SFS Wetland System

The main advantage of SFS wetland system is the prevention of mosquitoes and odors and elimination of the risk of public contact with the partially treated wastewater.

1. Determination of KT

$$K_T = K_{20} (1.1)^{(T-20)} \quad \text{Equation 5}$$

2. Determination of pore-space detention time (t')

$$\frac{C_e}{C_o} = \exp(-K_T t') \quad \text{Equation 6}$$

3. Determination of cross-sectional area (Ac)

$$A_C = \frac{Q}{K_S S} \quad \text{Equation 7}$$

4. Determination of basin width (W)

$$W = \frac{A_C}{d} \quad \text{Equation 8}$$

5. Determination of Basin length (L)

$$t' = \frac{LW\alpha d}{Q} \quad \text{Equation 9}$$

6. Determination of surface area (As)

$$As = L \times W \quad \text{Equation 10}$$

7. Checking hydraulic loading rate (Lw) or specific area (Asp)

$$A_{sp} = \frac{1}{L_w} \quad \text{Equation 11}$$

8. Checking BOD5 loading rate (LBOD5)

$$LBOD_5 = \frac{QC_O}{LW} \quad \text{Equation 12}$$

Table II. Design Results for wetland Systems

Types of Wetland System	Length (ft)	Width (ft)	BOD Removal Efficiency (%)
FWS System	7436	161.5	80.3
SFS System	743.6	52662.9	91.8

VI. CONCLUSIONS

For this paper, the following conclusions are pointed out Planting of water-hyacinths systematically is suitable for recreation center and wastewater treatment. Moreover, these plants give protective cover with their wide leaves from direct sunlight thereby minimizing evaporation of the lake. Constructed wetlands can remove BOD and Total Suspended Solids (TSS). In free water surface (FWS) wetland design, required length and width are 7406 ft and 740.6 ft respectively at temperature 25°C. BOD removal efficiency of FWS wetland design is 80.3%. In subsurface flow system (SFS) wetland design, required length and width are 161.5 ft and 52,662.9 ft respectively at temperature 25°C. BOD removal efficiency of SFS wetland design is 91.8%. Although the two wetland systems of BOD removal are not significantly different but required wetland area of SFS is about 1.5 times greater than FWS system. Therefore, FWS wetland system is suitable for KanDawGyi Lake as natural treatment system.

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