A STUDY ON THE EFFECTIVENESS OF THE ON-SITE DETENTION (OSD) FOR WATER QUALITY CONTROL

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Abstract
Water quality management are proposed to prevent, control or treat environmental problems related to quality of water, are broad and complex issues. In UTHM campus area, the water quality impacts or water quality control over time have not been studied in detail. Due to these complex issues, a well developed urbanization areas such as UTHM must have a well monitoring of quality assessment. In this research, a water quality monitoring has been carried out to study how effective an On-Site Detention pond that was developed in UTHM campus area in controlling water contamination. A few important of water quality parameter will be monitor by using three method of collecting data's by using on-site water quality monitoring equipment including self-monitoring equipment and portable water quality equipment. This equipments can analyzed more than five water quality parameters in a time and can be self-reading at site over time. A laboratory research also has been carried out to get the water quality index to classify all the important parameters of water quality according to water quality standards in Malaysia.

Keywords: on- site detention (OSD), Storm Management Manual (MSMA), Water Quality Index.

1.0 INTRODUCTION

To prevent, control, or treat environmental problems related to quality of water, a wide range of technical, economical, and social policies classified as water quality management have been proposed to be taken into account at different levels, from the general public to governments, especially in the final decades of the 20th century (Rubin, 2001).

On- site detention (OSD) is one of the simple ways to alleviate stormwater runoff by using natural process as to delay runoff though detention process. It has the ability to store and release stormwater at rates similar to rates existing prior to site development. Additionally, this process controls the rate of water flow that reduces downstream channel flood damage and erosion. The concept of On-Site Detention (OSD) pond also can be similar to wetlands function that cleans water through detention method and natural purification process (Yang et al. 2007).

1.1 Study Area

Water quality is affected by a wide range of natural and human influences (Meybeck, et al. 1996). More obvious are the polluting activities, such as the discharge of domestic, industrial, urban and other wastewaters into the watercourse (whether intentional or accidental) and the spreading of chemicals on agricultural land in the OSD pond. Due to this factor, a research on the effectiveness of the OSD design system in UTHM was carried out as to determine how effective that the OSD pond to control the water quality.

However, the main purpose of On-Site Detention design (OSD) has been a solution towards floods control in University Tun Hussein Onn Malaysia (UTHM) areas but, water quality monitoring has to be carrying out to determine the sources of pollution that contributed from surrounding areas. The UTHM new campus areas are using a MSMA drainage system which that picks runoff through to the OSD pond before it drained to the river.

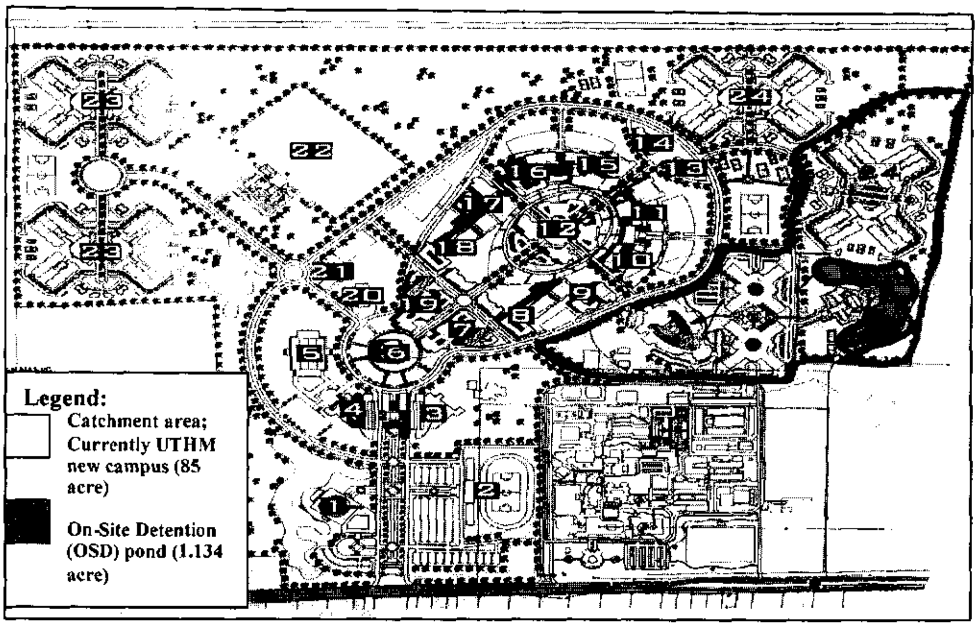

Figure 2.0 : UTHM campus area (including the catchment area of the OSD pond)
(Source; UTHM JKR & Pusat Pentadbiran Hartabina UTHM)

1.2 Problem statement

One of the problems that lead towards quality of water in the OSD pond is where the permeable soil is replaced by impermeable surfaces such as roads, roofs, parking lots, and sidewalks; store little water, reduce infiltration of water into the ground, and accelerate polluted runoff to ditches and streams. In fact, UTHM are using MSMA drainage system network (especially the inflow from the new campus areas) that accelerate runoff to the OSD pond. The weather changing will also effected the quality of the water in the OSD pond especially during floods that happening in January to February 2007.

Furthermore, stormwater washing across streets pick up spilled oil, solvents, pesticides and high chemical contents from the industrial activities and this can effected the water quality of the OSD pond.

1.3 Objectives

The objectives of the study are;

- To study the water treatment potential of OSD pond.
- To study the validation graph between seasons (during floods and dry season)
- To study the water quality parameter of the OSD pond. This including all the water quality parameter in calculating Water Quality Index (WQI).

1.4 Scope

The study is being conducted at the UTHM detention pond. This research focuses only on obtaining some of water quality parameter to determine if the water quality index of the detention pond meets the quality criteria of the water quality standard for Malaysia.

1.5 Contribution of Study

This study is important to determine effectiveness of the OSD pond base on the quality assessment. It is hoped that with the outcomes of this research it will be able to determine the suitability purpose of the pond in water quality control besides holding water during heavy rainfall that acts as flood control in the campus area.

Improving the water quality is also important in order to meet the water quality standard for Malaysia.

2.0 LITERATURE REVIEW

Many innovative ideas have been proposed and implemented to correct excess runoff in ever-growing urbanized areas (Konrad, 2003). It involves the development and implementation of a combination of structural and non-structural measures to reconcile the conveyance and storage function of stormwater systems with the space and related needs of an expanding urban population.

Fairly simple ways to alleviate stormwater runoff are by using natural process as to delay runoff though on- site detention basin. As runoff from roads is a major contributor to the quantity of surface water requiring disposal, this is a particularly beneficial approach where suitable ground conditions prevail (Butler and Davies 2000).

Furthermore, infiltration of storm runoff can reduce the concentration of diffuse pollutants such as leaves, feces, metals, and hydrocarbons, thereby improving the water quality of surface water runoff (Ellis et al. 2002; Scholz 2003, 2004).

The quality of water may be described in terms of the concentration and state (dissolved or particulate) of some or all of the organic and inorganic material present in the water, together with certain physical characteristics of the water. It is determined by in situ measurements and by examination of water samples on site or in the laboratory (Meybeck, et al. 1996).

To provide a comprehensive but easy to understand methodology for assessment and evaluation of water quality policies, the concept of water quality index (WQI) was introduced (Horton, 1965). A water quality index is a composition of parameters affecting the quality of water to summarize the water quality in a single score (Nasiri, et al. 2007).

2.1 Quality of OSD Pond

Quality analysis must be taken into consideration since pollution from stormwater runoff can be a major concern. This stormwater drains do not typically flow the water to directly to the basin, but carry runoff directly into streams before reaching the basin. Most surface pollutants are collected during the first one-half inch of rainfall in any stormwater event.

In the United States, the National Sanitation Foundation has developed a WQI since 1970. Around 142 water quality scientists were surveyed about 35 water quality parameters and asked to consider which of them should be included in an index (Nasiri, et al. 2007). Nine water quality parameters (dissolved oxygen, fecal coliform, biochemical oxygen demand, pH, nitrates, total phosphate, temperature change, turbidity, and total solids) were selected in calculating the water quality index. Then a weighted mean is used to combine the associated values of these parameters to get an overall index, ranging from 0 to 100. According to this calculated index, the quality of water is then represented by one of the possible categories of excellent, good, fair, poor, or very poor (Brown, et al. 1970; Mitchell and Stapp, 2000).

Thus, the obvious characteristics including all water quality parameters should be analyzed at the inlet and outlet of the basin. The result determine if the basin is efficient enough to meet the quality criteria of the water state by the government in order to remain at adequate and healthy levels for aquatic life and the surrounding housing area (Mamta Tomar, 1999).

3.0 METHODOLOGY

In this research, three equipment of Water Quality will be used to monitor water quality of the pond. We used three types of method collecting data because of the difference performance for each equipment. In-situ equipment only gives five parameters and Horiba water quality monitoring will gives six parameters. The main elements of water quality monitoring are:

1. On-site measurements
2. The collection and analysis of water samples
3. The study and evaluation of the analytical results
4. The report of the findings.

Below is the summary process of methodology in this research:

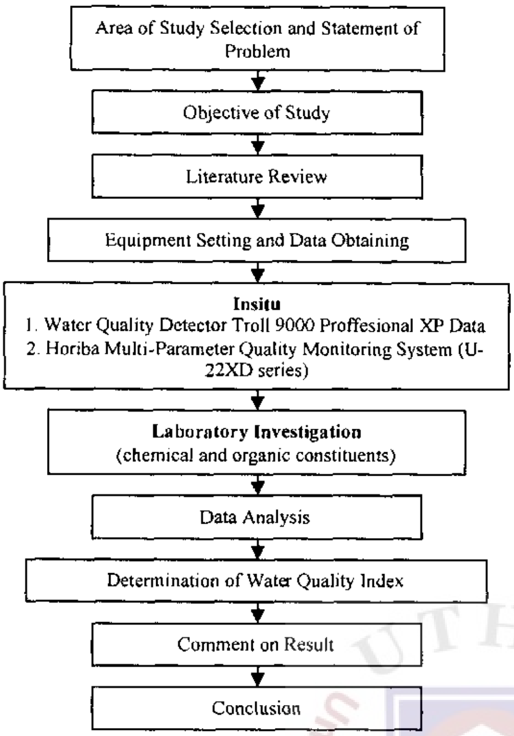

Figure 3.0: Flow Chart of Methodology

4.0 RESULTS AND ANALYSIS

The result of water quality analysis is to determine the efficiency of the OSD pond by controlling and determine the water quality index and also to monitor the main factor that can contribute any contamination of surface water and groundwater at the OSD pond.

4.1 Data Collection

The data collections for water quality analysis are divided into three methods of data collection which are:

1. By setting the Water Quality Detector Troll 9500 Professional XP Data Equipment at OSD Pond.
2. Manually collecting data at OSD site by using Horiba Multi-Parameter Quality Monitoring System (U-22XD series)
3. Determination of water quality by using laboratory investigation including chemical and organic constituents.

4.1.1 *Data collection from Water Quality Detector Troll 9500 Professional XP Data Equipment*

Only 5 parameters of water quality can be analyzed by using and setting the Water Quality Detector Troll 9500 Professional XP Data at OSD Pond. The parameters of measurements are:

1. Temperature (Celsius)
2. Turbidity (NTU)
3. Ph
4. Dissolve Oxygen (DO)(miligrams/L)
5. Conductivity (milisiemens/cm)

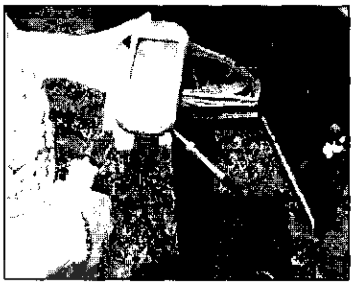

Figure 4.0: Reading from the Water Quality detector sensor to the PDA

After collecting all the data's needed, all the parameters of water quality as stated above will be downloaded by using the rugged reader equipment and transfers it to the computer by using Win Situ 4 Software. All the data's will be converted to Microsoft Excel Data Worksheet and finally analyzed the data's into graphs.

The data's are divided to two seasons of data collection which are data collections from January to February (during floods season) and the data collections from June to July (summer season). Below are the rainfall graph based on January, February, June and July rainfall data (source:*Jabatan Pengairan dan Saliran, Batu Pahat, Johor,2007*):

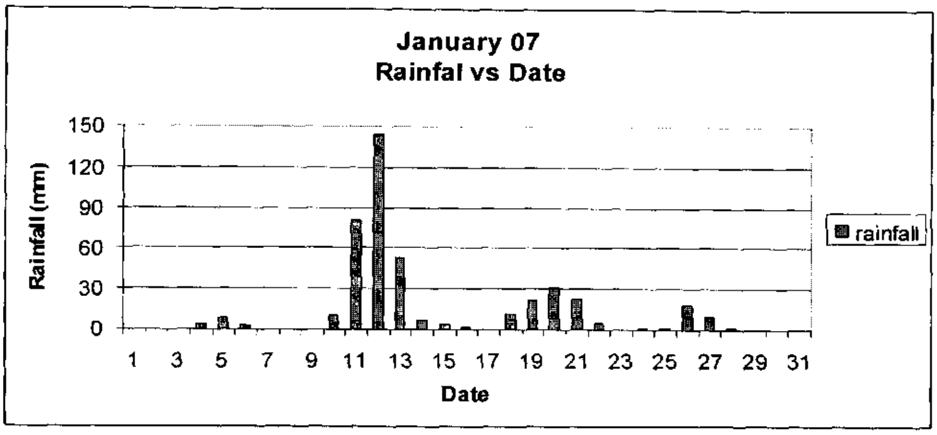

Figure 5: Daily Rainfall in January 2007

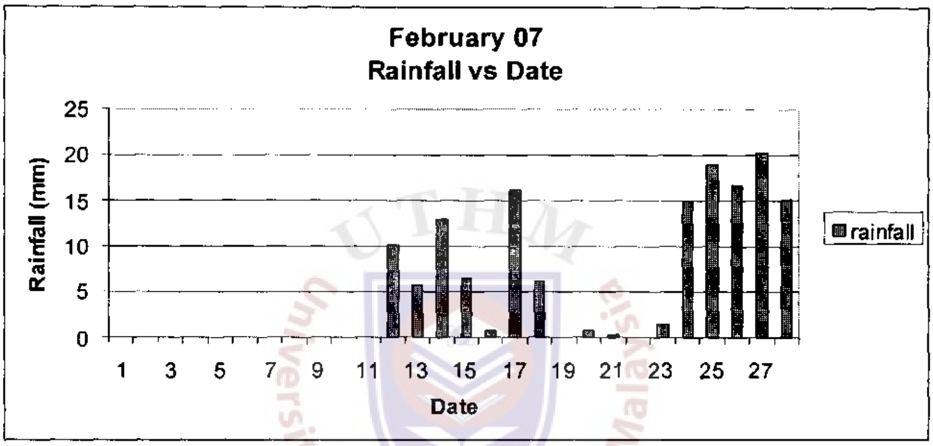

Figure 6: Daily Rainfall in February 2007

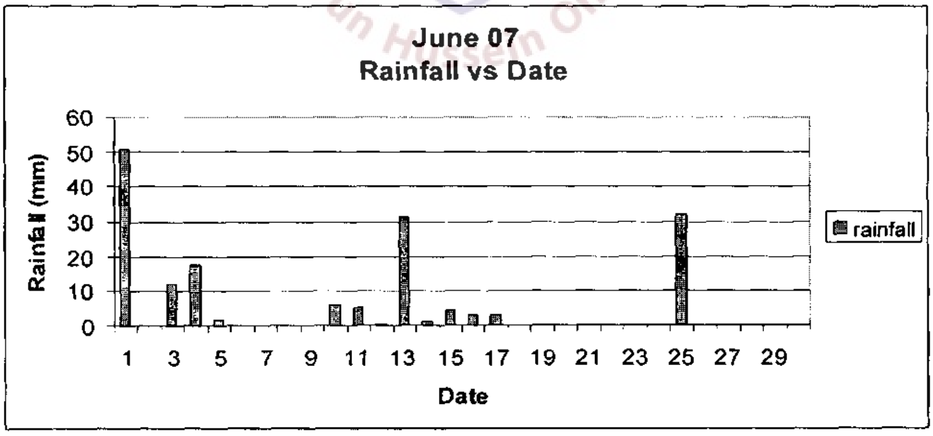

Figure 7: Daily Rainfall in June 2007

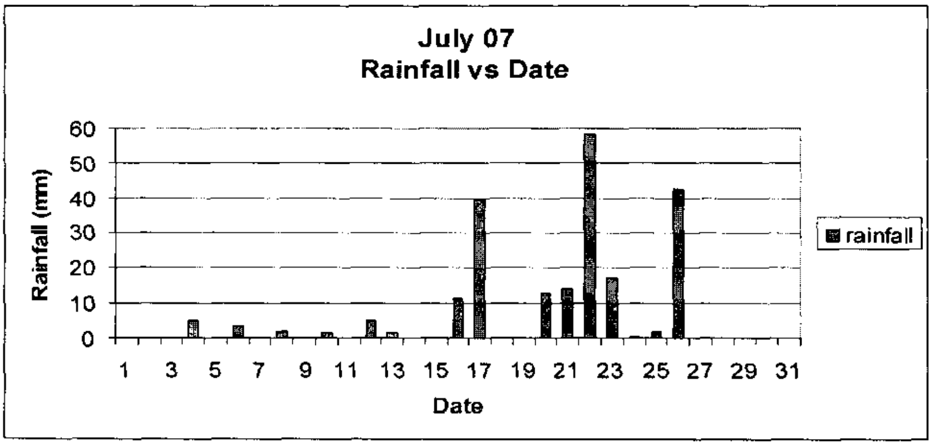

Figure 8: Daily Rainfall in July 2007

The result will come out with validation of graphs versus day. The value of water quality can be classifieds into classes that has been standardizing by the Malaysia Environmental Department (JAS). Below are the validation graphs:

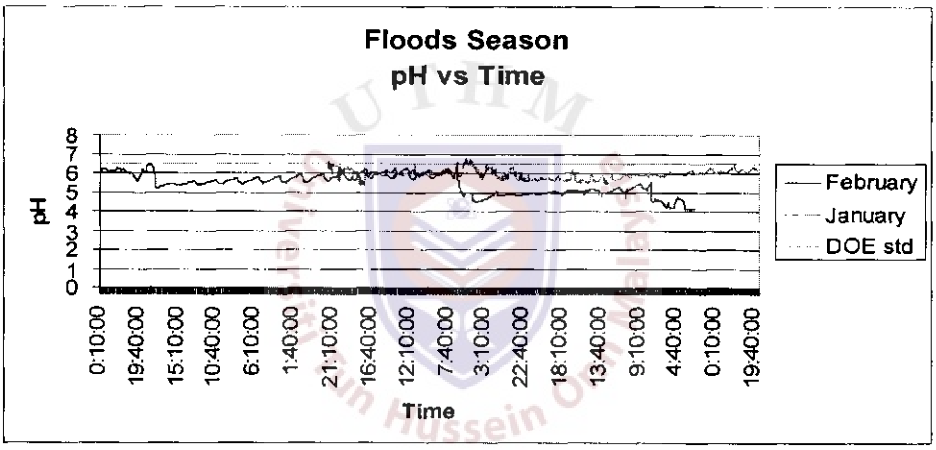

Figure 9: pH graph on Floods season (Jan 07-Feb 07)

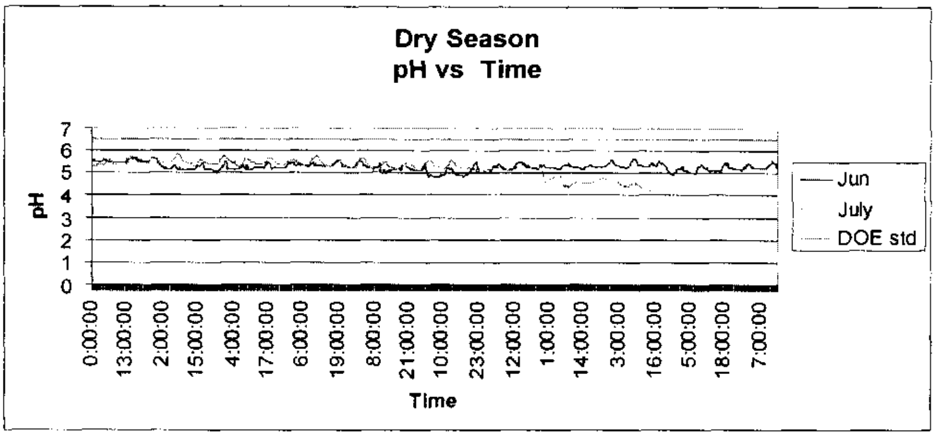

Figure 10: pH graph on Dry Season (June 07-July 07)

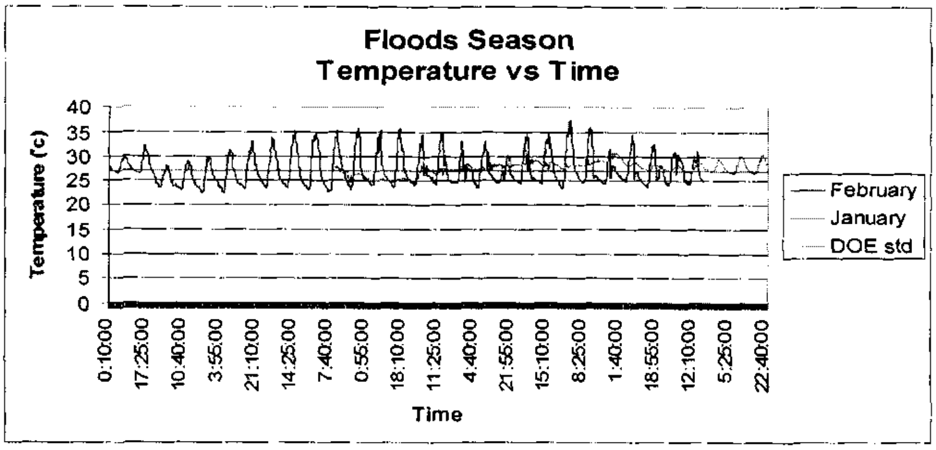

Figure 11: Temperature graph on Floods Season (Jan 07-Feb 07)

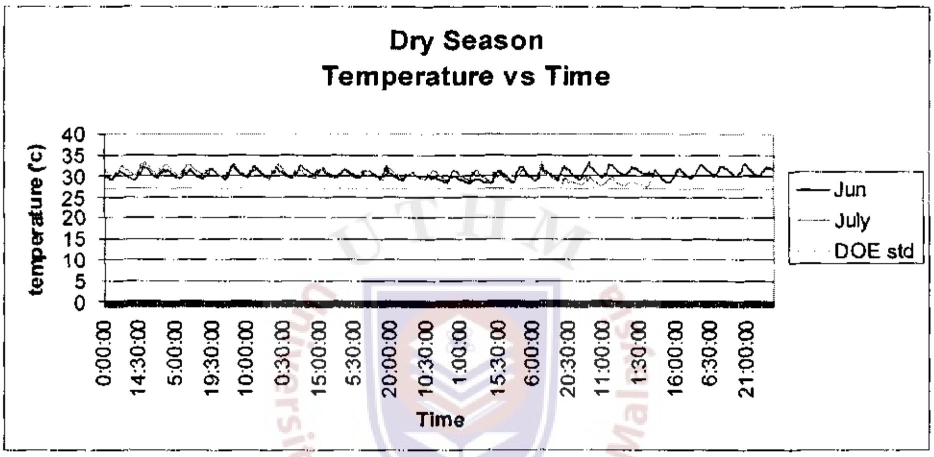

Figure 12: Temperature graph on Dry season (June 07-July 07)

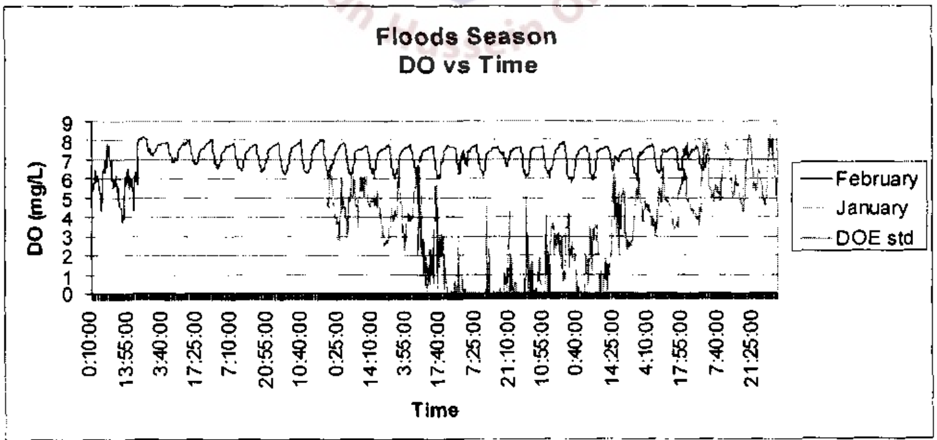

Figure 13: Dissolved Oxygen graph on Floods season (Jan 07-Feb 07)

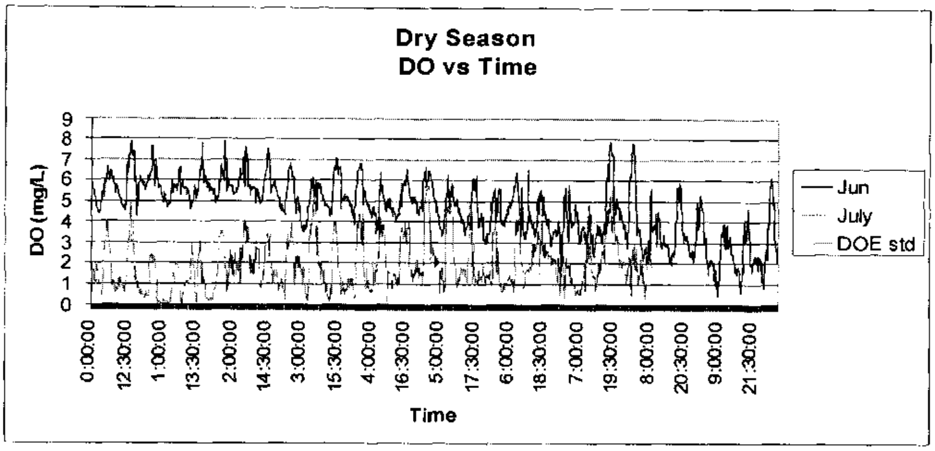

Figure 14: Dissolved Oxygen graph on Dry season (June 07-July 07)

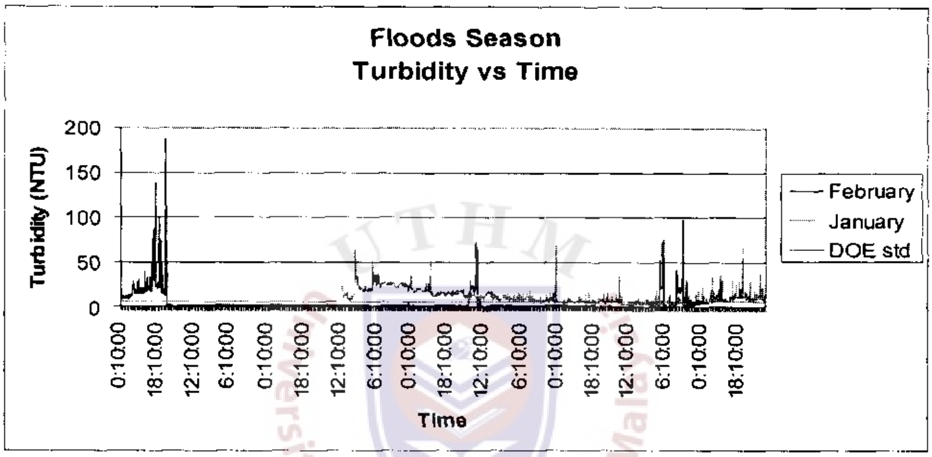

Figure 15: Turbidity graph on Floods season (Jan 07-Feb 07)

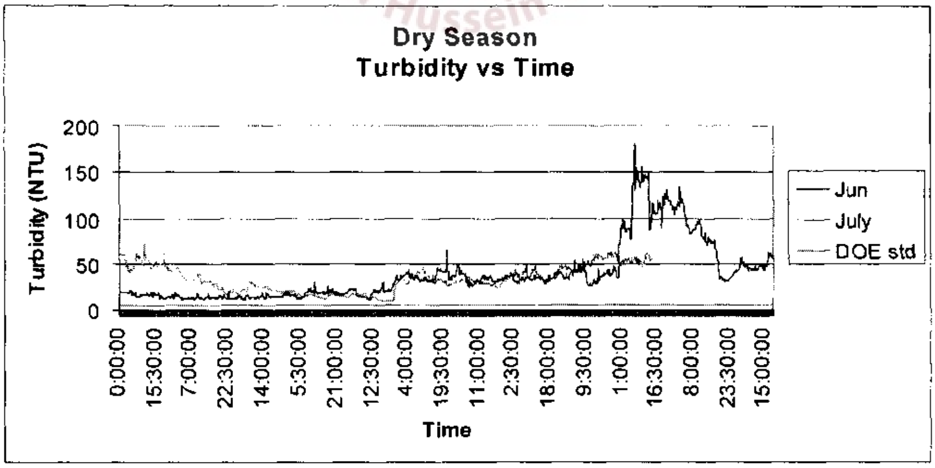

Figure 16: Turbidity graph on Dry season (June 07-July 07)

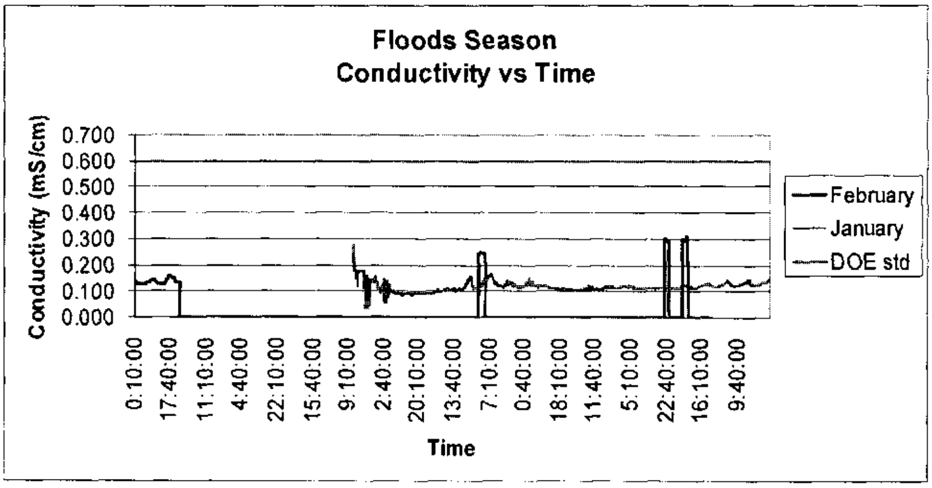

Figure 17: Conductivity graph on Floods season (Jan 07-Feb 07)

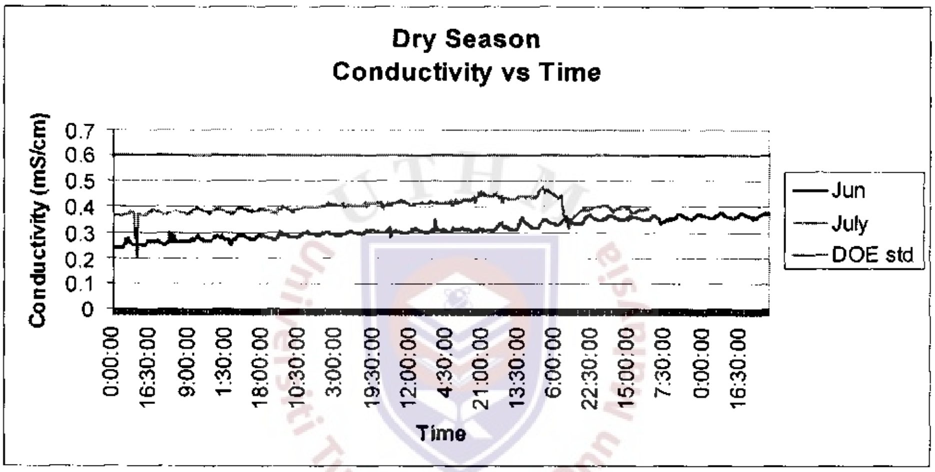

Figure 18: Conductivity graph on Dry season (June 07-July 07)

The pH of natural water is usually in the range of 5.5 to 7.0. At extremely high or low pH values the pond water becomes unsuitable for most organisms. According to the all graphs, the pattern of the validation graphs will varies differently between floods season and dry season. As we see in pH graphs, the pH value in January varies constantly if compare to pH in February. This is because in January the daily rainfall was high and suddenly floods were occurred in that month. It was continuously dragged-on until mid February. But in this case, we will see that in dry season, the pH value was down to be acidic because of in site investigation, the type of soil in the area was more to be acidic soil (clay, mud and peat). Furthermore, acidic waters can also cause heavy metals, such as copper and aluminum, to be released into the water.

For the Temperature graphs, the temperature in January varies constantly near to normal temperature but in February the temperature varies high because of the weather changing. In Jun and July, the temperature was varies constantly but was up above the normal condition (more than 27°c). The value of dissolved oxygen was varies not constantly in January due to the floods occurred but come back to normal condition in February and reached the line of DOE Water Quality Standard which was 7mg/L. in June and July the dissolved oxygen was going down the standard line due to the less of rainfall and hot season because warm water holds less oxygen than cooler water.

In January, June and July, the value of turbidity are constantly but in February, the value varies not constantly especially in early month due to the weather changing. If we look in the pattern of the graph, the value of turbidity will varies high if there was no rain in that day because the water was polluted with the soil types and the wastewater that flows from the industrial and the campus area. This contributed to the high range of turbidity value if compared to the DOE Standard. At higher levels of turbidity, water loses its ability to support a diversity of aquatic organisms. Waters become warmer as suspended particles absorb heat from sunlight, causing oxygen levels to fall (Remember, warm water holds less oxygen than cooler water).

General, a higher conductivity indicates that more material is dissolved material, which may contain more contaminants. Conductivity in water is influenced by the conductivity of rainwater, by road salt application, fertilizer application, and evaporation. Rainwater has variable conductivity depending on whether the rain clouds formed over the ocean which tends to have higher conductivity due to ocean salts or land. In this case, the value of conductivity was lower than the standard value so it contributed to normal condition.

Below is the table of summary results for Water Quality in January, February, June and July:

Table 1.0: Summary result for water quality data.

		Month			
		Wet Season		Dry Season	
Parameter (average)	**DOE std**	**Jan**	**Feb**	**Jun**	**July**
Temperature (°c)	25 - 28	27.50	27.18	30.37	30.10
Turbidity (NTU)	<5	11.61	5.19	38.82	33.46
pH	6.5 – 8.5	5.93	5.42	5.27	5.23
Dissolved Oxygen (mg/L)	>7	3.3	7.11	4.65	1.89
Conductivity (mS/cm)	0.45 -0.7	0.12	0.17	0.31	0.40

4.1.2 Data collection by using Horiba Multi-Parameter Quality Monitoring System (U-22XD series)

The components of parameter that can be measured by the Horiba U-22XD are as follows:

1. pH
2. Dissolved Oxygen (DO)
3. Conductivity (mS/cm)
4. Total Dissolved solids (TDS)
5. Temperature (°c)
6. Turbidity (NTU)

Table 2.0: Summary result for water quality data (taken in July, 2007).

		Location		
Parameter (average)	**DOE std**	**Inlet I**	**Inlet II**	**Outlet**
Temperature (°c)	25 - 28	28.8	28.6	30.2
Turbidity (NTU)	<5	110	193	70.4
pH	6.5 - 8.5	6.07	5.39	5.5
Dissolved Oxygen (mg/L)	>7	4.8	6.06	7.19
Conductivity (mS/cm)	0.45 - 0.7	0.57	0.54	0.36
Total Dissolved solid (g/L)	0.25 - 0.5	0.36	0.36	0.25

The temperature was rising at outlet because of hot season. This is also effected the Dissolved Oxygen value because warm water cannot hold more oxygen than cold water. pH value also not meets the standard requirement due to the acidic soil and industrial contaminants.

4.1.3 *Determination of water quality by using laboratory investigation including chemical and organic constituents.*

There are many parameter of water quality that can be analyzing by using laboratory investigation. In this research, there are only few important parameters that have to be analyzed which that contributed to water quality index in Malaysia which are:

1. Dissolved Oxygen (%sat)
2. pH
3. Temperature (°c)
4. Turbidity (NTU)
5. Total Suspended Solid (mg/L)
6. Phosphate (mg/L)
7. Nitrates (mg/L)
8. Fecal Coliform
9. BOD
10. COD

Below is the table of summary result of the water quality laboratory research with water quality index that calculated for all nine parameters that used in this research. The results will be classified according to DOE Water Quality Standard for Malaysia.

Table 3.0: Summary result of water Quality index at OSD pond in UTHM.

Parameter (average)	Inlet I	WQI	Inlet II	WQI	Outlet	WQI
Dissolved Oxygen (%sat)	63.2	62	79.7	87	94.6	98
pH	6.07	56	5.39	53	5.5	41
Temperature (°c)	28.8	98	28.6	97	30.2	90
Turbidity (NTU)	110	5	193	5	70.4	29
Total Suspended Solid (mg/L)	22.8	84	23.3	84	20.6	84
Phosphate (mg/L)	0.26	86	0.30	86	0.68	51
Nitrates (mg/L)	0.15	97	0.85	96	0.50	97
Fecal Coliform	1.2	97	1.4	95	1.0	99
BOD	3.9	62	3.7	63	3.0	67
Status = Class II	**Good**	73	**Good**	77	**Good**	76

Table 4.0 : WQI Legend
(Source: National Sanitation Foundation, US, 1970)

Water Quality Index Legend	
Range	**Quality**
90-100	Excellent
70-90	Good
50-70	Medium
25-50	Bad
0-25	Very bad

Table 5.0: DOE Water Quality Index Classes
(Sources: Interim National Water Quality Standards for Malaysia, 2005)

Parameter	Unit	Classes I	II	III	IV	V
Ammoniacal Nitrogen	mg/l	< 0.1	0.1 - 0.3	0.3 - 0.9	0.9 - 2.7	> 2.7
Biochemical Oxygen Demand	mg/l	< 1	1-3	3-6	6-12	> 12
Chemical Oxygen Demand	mg/l	< 10	10-25	25 - 50	50 - 100	> 100
Dissolved Oksigen	mg/l	> 7	7-5	5-3	3-1	< 1
pH	mg/l	> 7.0	6.0 - 7.0	5.0 - 6.0	< 5.0	> 5.0
Total Suspended Solids	mg/l	< 25	25 - 50	50 - 150	150- 300	> 300
Water Quality Index		> 92. 7	70.5-92.7	51.9-70.5	31.0-51.9	< 31.0

Class	Uses
Class I	: Conservation of natural environment water supply I- practically not treatment necessary. Fishery I – very sensitive aquatic species
Class IIA	: Water supply II – conventional treatment required Fishery II – sensitive aquatic species
Class IIB	: Recreational use with body contact
Class III	: Water supply III – extensive treatment required Fishery III – common, of economic value and tolerant species livestock drinking
Class IV & V	: Irrigation

5.0 CONCLUSION AND RECOMMENDATION

5.1 Conclusion

From the quality results analysis, the water OSD pond can be classified into Class II which is suitable Water supply with conventional treatment required. It is also suitable for sensitive aquatic species and recreational use with body contact.

This is because the rainwater washing across streets and sidewalks can pick up spilled oil, detergents, solvents, pesticides, fertilizer and high chemical contents (including heavy metals) from the industrial activities and from the UTHM Campus.

5.2 Recommendation

One effective way to improve water quality is to get more oxygen in the water by cleaning the pond once a while. Aeration is often performed by sending compressed air to an air diffuser at the bottom of the pond. The deep water rises to the surface and the water molecules grab oxygen from the atmosphere. As the pond water circulates, soon the oxygen levels in the water from top to bottom increase. This is also as one of the way to control pollution as well.

Vegetative buffers or strips can be planted between areas of potential erosion and sensitive zones, such as streams, to reduce the discharge of sediment. Furthermore, it is also be has the ability to detain runoff and allow sediment to settle to the bottom.

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