THE ENVIRONMI [illegible] WASTEWATER IN LANDSCAPE WATERING

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A thesis submitted in fulfillment of the requirements for the award of the degree of Bachelor of Civil Engineering

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JUNE 2012

ABSTRACT

Nowadays, the wastewater has been used in variety application. Sewage effluent is a major source of water pollution in our country whereas in other countries. With proper water quality control, sewage effluent can also be considered as a potential resource for specific applications. Therefore, this study was carried out to establish the potential of reusing sewage effluent from wastewater treatment plants to irrigate landscape plants. This study aims to gather more information about the suitability of the effluent in landscape irrigation. Besides, we also aims to determine the reduction of effluent discharge and cost if this wastewater reuse is practiced. Furthermore, it is found that sunlight could reduce the concentration of *F. coli* and *E. coli* at surface of landscape plants. The quality of treated effluent from selected oxidation pond of University Malaysia Pahang was found to be suitable for irrigation.

ABSTRAK

Pada masa kini, efluen kumbahan telah digunakan semula untuk pelbagai jenis aplikasi. Efluen kumbahan merupakan punca utama yang menyebabkan pencemaran air sungai di negara kita dan juga di kebanyakan negara lain. Dengan adanya kawalan kualiti yang baik, maka efluen kumbahan berpotensi untuk dijadikan sebagai salah satu sumber air bagi aplikasi-aplikasi yang spesifik. Dengan itu, kajian ini dijalankan bagi mengkaji kesesuaian dan potensi guna semula efluen kumbahan dari loji olahan air sisa untuk tujuan penyiraman tumbuhan lanskap dalam tapak penyiraman lanskap. Selain itu juga, kajian mendapati bahawa sinaran matahari dapat mengurangkan penunpuan *F.coli* dan *E.coli* pada permukaan tumbuhan lanskap. Efluen kumbahan daripada kolam pengoksidaan Universiti Malaysia Pahang didapati sesuai untuk tujuan penyiraman lanskap.

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WTP	-	Water treatment
UMP	-	University Malaysia Pahang
DOE	-	Department of Environment
DO	-	Dissolved oxygen
BOD	-	Biochemical oxygen demand
MWRSA	-	Monterey Wasewater Recalimation Study of Agriculture
UAPC	-	United Agricultural Production Company
NH_3N	-	Ammonium
INWQS	-	Interim National Water Quality Standard for Malaysia.
TSS	-	Total Suspended Solid

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CHAPTER 1

INTRODUCTION

1.1 Research Background

Water can be considered as a reclaimable resource of inestimable value and increasing scarcity. Inadequate water supplies limit the quality of life and limit municipal and industrial growth. In fact, water scarcity has created chaos, as previously in the Middle East water scarcity has already created war. (WEM, 2007)

Recently, more specifically at the beginning of 2007, the United Nation has warned that India and China are running short of water. In fact, the water shortage problem is not only faced by the scarce water regions, and fortunate country with water rich has to find alternatives towards their water resource in order to prevent the problem.

As Malaysia can be seen as developing country with the augmentation of population, this situation makes the sewage become increasing from days to days. Normally, treated sewage effluent will be discharged into the existing rivers nearby the water treatment plant (WTP) facility.

Wastewater reuse has long been practiced throughout the world. These reused practices can be divided into direct and indirect reuse. Direct use has been commonly accepted for agriculture and landscape irrigation and for some industrial uses such as power plant cooling. Indirect reuse however has existed for almost every type of beneficial use of water through the discharge of treated wastewater into a stream that forms the principal water supply of a downstream community or industry.

Due to the beneficial usage of treated wastewater, it is therefore seems to be potentially implemented in University Malaysia Pahang (UMP) especially in landscape watering.

1.2 Objectives of Research

1) To determine the quantity of effluent loading from wastewater treatment plant (WTP) in the study area.
2) To estimate the amount of effluent that can be used for landscape watering.
3) To estimate the reduction that can be achieved if wastewater is used for landscape watering.

1.3 Problem Statements

In 1998, the Department of Environmental of Malaysia has reported a list of activities that has contributed to the water pollution in Malaysia. (DOE, 1998)

Sewage activities was reported as the major source of pollution with 5665 cases followed by manufacturing (5029 cases), farming (2235 cases) and agriculture activities (469 cases)

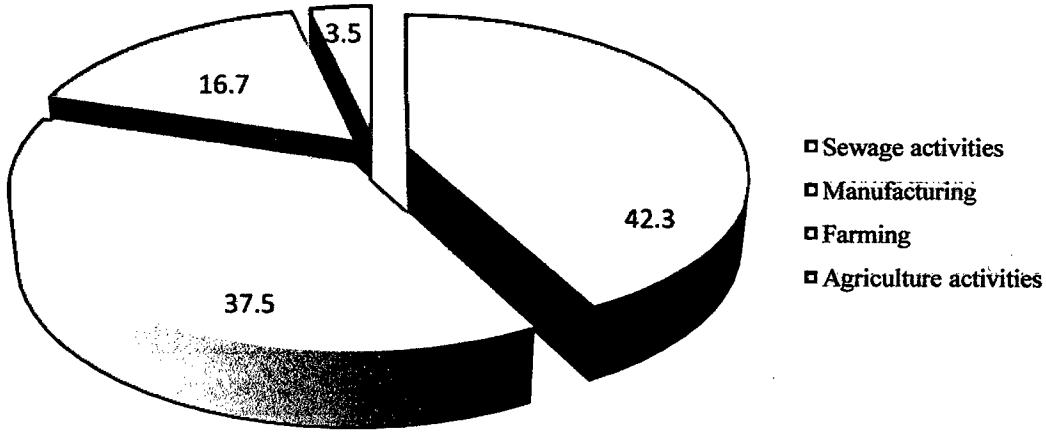

Figure 1.1: Percentage of activities contributing to water pollution in Malaysia

Since the 90's, Malaysia has became a fast developing nation. Thus, it has resulted in more drastically demand on water usage. However, at the same time, the available water sources exposes to contamination risk.

Therefore, it is a need to have a study to come out with an alternative ways to reduce the contamination of receiving streams and waterways. In addition, this study will also come out with how much the beneficial use of treated wastewater will be able to reduce the burden of tap water cost by University Malaysia Pahang (UMP).

UMP spends a lot of money in paying the bill of water usage every month and a part of it is for the landscape irrigation. The plants in UMP now are worked to make them grow up faster to give all students more shady places. But, one of the problem is that the soil condition in UMP which that the soil fertility is not good. There are more than 10 species of plants in UMP need to be taken care every day.

1.4 Scope of Study

1) This study is carried out in 3 months.
2) The study is focusing on the benefit of effluent reuses in landscape watering.
3) The study is carried out according to the effluent from water treatment plant of UMP Gambang campus and the percentage area at the UMP Gambang campus.

CHAPTER 2

LITERATURE REVIEW

2.1 Water crisis

The world's supply of fresh water is running out. This water crisis is increasing as population of people increases. The two main issues in water crisis are water shortage and water scarcity. This happens in many countries all over the world.

As population increases, water is being perceived as a very valuable resource. Every effort is exerted to use water more efficiently and to make use of every drop of water to ensure the well-being of future generations. New trends are developed and practiced in the area of water resources use and water saving. However, the ways to overcome this water crisis vary from one country to another according to the degree of water scarcity, economic situations, and other factors. (*Khaled M. Abu-Zeid, 1998*)

Water shortage and water pollution are two of the most important environmental problems and factors affecting the development of industry, agriculture and the economy. Water saving and waste water reuse are the most significant measures implemented for solving the water shortage and controlling water pollution. (*Xie Yongming, 1992*)

Whatever the use of freshwater (agriculture, industry, domestic use), huge saving of water and improving of water management is possible. Almost everywhere, water is wasted, and as long as people are not facing water scarcity, they believe access to water is an obvious and natural thing. With urbanization and changes in lifestyle, water consumption is bound to increase.

2.2 Water pollution

Water pollution is a major problem in the global context. It has been suggested that it is the leading worldwide cause of deaths and diseases especially in India and China. It leads to deaths and diseases. An estimated 700 million Indians have no access to a proper toilet, and 1,000 Indian children die of diarrhea sickness every day. Some 90% of China's cities suffer from some degree of water pollution, and nearly 500 million people lack access to safe drinking water. In addition to the acute problems of water pollution in developing countries, industrialized countries continue to struggle with pollution problems as well. In the most recent national report on water quality in the United States, 45 percent of assessed stream miles, 47 percent of assessed lake acres, and 32% of assessed bay and estuarine square miles were classified as polluted (*Wikipedia, 2010*).

The Department of Environment (DOE) maintains mainly records of point sources. In 2008, 17,633 water pollution point sources were recorded. These comprise of sewage treatment plants *(9,524:* 54.01% inclusive of 668 Network Pump Stations), manufacturing industries (6,830: 38.73 0/o), animal farm (788: 4.48%) and agro-based industries (491:2.78%) as shown in Figure 2.1. The number of sewage treatment plants under the management of Indah Water Konsortium Sdn. Bhd. (IWK) had increased from 9,337 plants in 2007 to 9,524 plants in 2008. Selangor had the largest number of sewage treatment plants *(2,715::* 28.50/o), followed .by Perak (1,422: 14.9%), Johor (1,061: 11.1%) and Negeri Sembilan (945: 9.9%)

2.2.1 Types of water pollution

Water pollution can come from a number of different sources. If the pollution comes from a single source, such as an oil spill, it is called point-source pollution. If the pollution comes from many sources, it is called nonpoint-source pollution. Most types of pollution affect the immediate area surrounding the source.

2.2.1.1 Microbiological water pollution

Microbiological water pollution is usually a natural form of water pollution caused by microorganisms. Many types of microorganisms live in water and cause fish, land animals and humans to become ill. Microorganisms such as:

- Bacteria
- Viruses
- Protozoa

Serious diseases such as cholera come from microorganisms that live in water. These diseases usually affect the health of people in poorer countries, as they do not have the facilities to treat polluted water.

2.2.1.2 Chemical Water Pollution

Industrial and agricultural work involves the use of many different chemicals that can run-off into water and pollute it.

- Metals and solvents from industrial work can pollute rivers and lakes. These are poisonous to many forms of aquatic life and may slow their development, make them infertile or even result in death.
- Pesticides are used in farming to control weeds, insects and fungi. Run-offs of these pesticides can cause water pollution and poison aquatic life. Subsequently, birds, humans and other animals may be poisoned if they eat infected fish.
- Petroleum is another form of chemical pollutant that usually contaminates water through oil spills when a ship ruptures. Oil spills usually have only a localized affect on wildlife but can spread for miles. The oil can cause the death of many fish and stick to the feathers of seabirds causing them to lose the ability to fly.

2.2.1.3 Oxygen depleting water pollution

Microorganisms that live in water feed on biodegradable substances. When too much biodegradable material is added to water, the number of microorganisms increase and use up the available oxygen. This is called oxygen depletion.

When oxygen levels in the water are depleted, relatively harmless aerobic microorganisms die and anaerobic microorganisms begin to thrive. Some anaerobic microorganisms are harmful to people, animals and the environment, as they produce harmful toxins such as ammonia and sulfides.

2.2.1.4 Nutrients water pollution

Nutrients are essential for plant growth and development. Many nutrients are found in wastewater and fertilizers, and these can cause excess weed and algae growth if large concentrations end up in water.

- This can contaminate drinking water and clog filters.
- This can be damaging to other aquatic organisms as the algae use up the oxygen in the water, leaving none for the surrounding marine life.

2.2.1.5 Suspended matter water pollution

Some pollutants do not dissolve in water as their molecules are too big to mix between the water molecules. This material is called particulate matter and can often be a cause of water pollution.

- The suspended particles eventually settle and cause thick silt at the bottom. This is harmful to marine life that lives on the floor of rivers or lakes.
- Biodegradable substances are often suspended in water and can cause problems by increasing the amount of anaerobic microorganisms present.
- Toxic chemicals suspended in water can be harmful to the development and survival of aquatic life

2.3 Wastewater

Wastewater is any water that has been adversely affected in quality by anthropogenic influence. It comprises liquid waste discharge by domestic residences, commercial properties, industries, or agriculture and can encompass a wide range of potential contaminant and concentration. In the most common usage, it refers to the municipal wastewater that contains a broad spectrum of contaminant resulting from the mixing of wastewater from different sources (*Salt, 2001*).

Generally, wastewater is synonymously with sewage even though sewage is a more general term that refers to any polluted water including wastewater, which may contain organic and inorganic substance, industrial waste, groundwater that happens to infiltration and to mix with contaminated water, storm, runoff, and other similar liquids (*Miretzky et al. 2004*).

Untreated or improperly treated wastewater contains biological contaminants known to cause disease. These contaminants are known as germs or pathogens. Pathogens fall into five main categories: bacteria, viruses, protozoans, fungi, and worms. Most of these pathogens use the fecal/oral route to spread disease. Fecal material, including human waste, contains pathogens. The usual method of infection requires you to touch the fecal material with your hands and then transfer it to your mouth, either directly or through food. Pathogens can also contaminate water supplies when the wastewater is allowed to reach the water table before adequate treatment occurs.

1. Bacteria

Bacteria are microscopic, single celled organisms that are typically round (Cocci), rod shaped (Bacillus), or spiral (Spirochetsia). Bacterial shapes come from three groups. Diplo means two bacteria attached together, Strepto means a twisted chain of bacteria, and Staphylo means a large clump of bacteria. Some diseases caused by bacteria are cholera, which causes vomiting, diarrhea, dehydration and even death; typhoid, which

causes fever, chills, and sometimes death; salmonella, which causes fever, nausea, vomiting, bloody diarrhea, cramps and sometimes death; shigella, which causes fever, nausea, vomiting and diarrhea; and staphylococcus, which causes skin infections and mucus membrane infections.

2. Virus

Viruses use living cells to reproduce and cause infections. The virus penetrates the cell wall of the host, injects genetic material into it, and the host's infected cell makes more virus.

Viruses are generally smaller than bacteria, but they can be more deadly. Diseases caused by viruses include hepatitis A, a viral infection of the liver which causes nausea, vomiting, diarrhea, skin and urine discoloration, weakness, and sometimes liver damage; gastroenteritis, a viral infection of the intestinal tract which causes fever, nausea, vomiting, diarrhea and pain; and polio, which causes inflamation of motor neurons of the spinal cord and brainstem, leading to paralysis, muscular atrophy and deformity, and sometimes death.

3. Fungi

Fungi are non-photosynthetic living organisms such as yeast. They can be a single cell or a body mass of branched filaments. Diseases caused by fungi include candidiasis, which is transmitted by contact with feces or secretions from infected people. Although it usually causes mild infections, occasionally it may cause ulcers in the intestinal tract or lesions in the kidneys, brain or other organs.

4. Protozoans

Protozoans are large (compared to bacteria) single celled animals which have the ability to move. Diseases caused by bacteria include amoebiasis, which causes bloody

diarrhea and sometimes death; and giardiasis, which causes diarrhea and severe gas. Perhaps the best known incidence of sickness caused by a protozoan is "Cryptosporidiosis". Caused by Cryptosporidium, the infection in humans can be divided into two distinctly different diseases, depending on the patient's immune status. Both forms have an incubation period of four to fourteen days. In the immune competent host, the onset is sudden. There is marked watery diarrhea, cramping, abdominal pain, and flatulence. Nausea, vomiting, fever, anorexia, weight loss, myalgia, and malaise may also be present. Symptoms usually begin to subside in five to ten days. In immunocompromised patients (cancer, AIDS, elderly, previously diseased), the onset is more gradual, and the symptoms are more severe. Fluid losses may be excessive. Weight loss may exceed 10% of the patient's original body weight. The duration of the illness may be indefinite. The deaths are usually in the immunocompetent host and are usually from loss of water to the system, loss of nutrition and no ability to fight the disease. There are few medications available to fight this disease.

5. Worms

This category includes hook, round, pin, tape and flatworms. In an ancylostomiasis infection, a hookworm penetrates the skin of the feet and travels to the gut. Ascariasis, a roundworm, lays eggs in sewage contaminated soil, which is ingested by an individual with dirty hands. The worms develop in the gut, attack the lungs, liver and other organs.

2.3.1 Characteristic of Wastewater

In general, wastewater is water that has been generated from domestic and industrial sources where throughout the world by dumping 10,000 new organic compounds each year. These compound needs to be properly handled and removed if they cause health problem. There are many industrial plants that have required pretreating

their wastewater before dumping in the wastewater system (*Chandra and Kulshrenta, 2004*).

It is necessary to identify the characteristics wastewater in order to rectify the problems caused by them. Wastewater is characterized in terms of its physical, chemical and biological composition.

2.3.1.1 Physical Characteristic of Wastewater

Physical characteristics of wastewater are much easier to determine and measure and they are as below:

1) Temperature

The temperature of wastewater varies greatly, depending upon the type of operations being conducted at your installation. Wide variation in the wastewater temperature indicates heated or cooled discharges, often of substantial volume. They have any one of a number of sources. For example, decreased temperatures after a snowmelt or rainfall may indicate serious infiltration. Changes in wastewater temperatures affect the settling rates, dissolved oxygen levels, and biological action. The temperature of wastewater becomes extremely important in certain wastewater unit operations such as sedimentation tanks and recirculating filters.

2) Colour

The color of wastewater containing dissolved oxygen (DO) is normally gray. Black-colored wastewater usually accompanied by foul odors, containing little or no DO, is said to be*septic.*

Table 2.1 Significance of colour in wastewater

Unit process	Colour	Problem indicated
Influent of plant	Gray	None
	Red	Blood or other industrial waste or TNT complex
	Green, yellow, other	Industrial wastes not pretreated
	Red or other soil colour	Surface runoff into influent, also industrial flows
	Black	Septic conditions or industrial flows

3) Odour

Domestic sewage should have a musty odor. Bubbling gas and/or foul odor may indicate industrial wastes, anaerobic (septic) conditions, and operational problems.

4) Solids

Wastewater is normally 99.9 percent water and 0.1 percent solids. If a wastewater sample is evaporated, the solids remaining are called *total solids.*

The amount of solids in the drinking water system has a significant effect on the total solids concentration in the raw sewage. Industrial and domestic discharges also add solids to the plant *influent.* There are many different ways to classify solids. The most common types are dissolved, suspended, settleable, floatable, colloidal, organic, and inorganic solids.

Part of the total solids is dissolved in wastewater. Much like sugar dissolves in coffee, many solids dissolve in water. Dissolved solids pass

through a fine mesh filter. Normal wastewater processes using settling or flotation are designed to remove solids but cannot remove dissolved solids. Biological treatment units such as trickling filters and activated sludge plants convert some of these dissolved solids into settleable solids that are then removed by sedimentation tanks.

Those solids that are not dissolved in wastewater are called *suspended solids.* When suspended solids float, they are called *floatable solids* or scum. Those suspended solids that settle are called settleable solids, grit, or *sludge.* Very small suspended solids that neither float nor

2.3.2 Wastewater Treatment

The primary purpose of wastewater treatment is protecting the health and well-being of our community. The objectives include:

1) Prevention of disease and nuisance conditions
2) Avoidance of contamination of water supplies and navigable waters
3) Maintenance of clean water for survival of fish, bathing and recreation
4) General conservation of water for all uses.

The process removes organics, solids and pathogenic organisms from the water or changes them from complex makeup to stable minerals or organics that can be compatible with the environment.

Without adequate treatment, many of the objectionable characteristics of decaying wastewater could show up in the local waterways. These could consist of noticeable things such as disagreeable odors, discoloration of the water and sludge deposits or factors that cannot be seen, such as disease producing bacteria. The presence of any of