Appraisal of Septic Tank in Term of Water Stagnation in Properties

by

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the requirements for the
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CERTIFICATION OF APPROVAL

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Approved by,

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December 2006

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained herein have not been undertaken or done by unspecified sources or persons.

FATINI BINTI NAZIRAN

ABSTRACT

The title of this project is 'Appraisal of Septic Tank in Term of Water Stagnation in Properties'. This project is based on problem arising on the domestic wastewater treatment unit namely septic tank. An ineffective septic tank may lead to water flow disruption and cause stagnation inside septic tank. The stagnant water has become a breeding ground for mosquitoes. Septic tanks for instance relatively contain clean water with low turbidity; hence it is likely to be capable for breeding mosquito. The damage of septic tank cover, manholes and vent pipes provide access for mosquito to enter inside the tank. Taman Megah Tiga and Taman Mas Kg Kok in Sitiawan town, and also Taman Maju in Perak Tengah district have been selected as study area due to many cases of dengue infection that results in death. Basically it is aimed to review the structural design and to examine the maintenance program by local authority and health department in order to avoid water stagnation which later becomes breeding ground for mosquitoes. For the first semester, the scope was focused on examining the drainage system design and the stagnant water quality in study area. In addition, the population of Aedes mosquitoes is also being counted by ovitrap surveys. This project was done in Universiti Teknologi Petronas (UTP) to control the population of mosquito by prevents it from further breeding. Then for another semester, the scope is to proposed modification for the existing drainage structure design. Water sampling and laboratory experiments for water quality test is carried out throughout this process. Finally this project hopefully will come out with an improvement in drainage design and maintenance programme to avoid mosquito breeding inside the structures.

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CHAPTER 1

INTRODUCTION

1.1 Background of Study

A septic system is an efficient, inexpensive, convenient, and safe method for treating and disposing of household wastewater before it is recycled back to the groundwater system. A conventional septic system consists of four main parts which are the source, septic tank, drainfield, and soil beneath the drainfield [1]. The septic tank is an enclosed receptacle designed to collect wastewater, segregate settleable and floatable solids (*sludge and scum*), accumulate, consolidate and store solids, digest organic matter and discharge treated effluent [2].

The septic tank collects and stores the solids that come from the house. However, an improper design of the structure will cause water stagnation inside the tank. The liquid portion of the wastewater supposes to flow out into the drainfield. Therefore, it is not impossible for mosquitoes to breed in this kind of environment, where there is no biological control in the system. Eventually, this may contribute to the problems of dengue fever in urban property areas.

Septic tank has been identified as a common source for mosquito breeding. The physical conditions itself contribute to the problem. The septic tank that are not properly installed or maintained will allow mosquitoes to enter the system. The House Mosquito, *Culex pipiens* thrives in these water sources [3]. Exposed tanks or manhole lids, opening ventilation pipe, and failure of pump system shall give reasons for mosquito breeding.

In the past, there has been a tendency amongst civil engineers not to concern themselves in any detail with the quality aspects of wastewater which is conveyed in

the system they design and operate. This is a mistake for a several reasons. Therefore, all these have created such problems like's mosquitoes breeding especially Aedes.

deread by the bite of an Aedes mosquito. The mosquito transmits the disease by biting an infected person and then biting someone else. The mosquitoes that transmit dengue live among humans and breed in a place where water stagnates such as in drains, discarded tires, flower pots, old oil drum, and water storage containers.

1.2 Problem Statement

The most valuable benefit of an effective urban drainage system is the maintenance of public health by protecting against the spread of disease. Many engineering structures in properties area such as septic tank, gutter and immediate sand trap to houses area retain water in which they become the mosquito breeding habitats. However the projects will only focusing on problem with conventional septic tank system and maintenance. An ineffective septic system may lead to water flow disruption and cause stagnation inside septic tank. The stagnant water has become a breeding ground for mosquitoes. Septic tanks for instance relatively contain clean water with low turbidity; hence it is likely to be capable for breeding mosquito.

Septic tank systems are typically simple in design and generally less expensive to install and maintain. However, for a poorly maintained system, the effluent discharged still has a high amount of biodegradable organic material along with high bacterial content. Worst of all, septic tanks, manholes and vent pipes are the favorite place for mosquito's breeding ground. The ventilation pipe usually is designed without mosquito proofed while the outlet pipes are connected to open drains which support profuse breeding of mosquitoes. Apart from that, damaged slabs make the septic tanks conducive for mosquito entry and breeding. Some other related problem that has been recognized in septic tank is dysfunctional of pump system. If the liquid level in the tank is too high, it indicates that the pump may not be operating properly. The failure of pump to suck out water will cause the water to stagnate inside the tank.

1.3 Objectives

The objectives of the project are as follows:

- To study on the common functionality problems faced by individual septic tank within the premises area.
- To study the design water treatment facilities namely septic tank, the water quality and breeding mosquito.
- To propose modification on the existing structures design that retains water, so that can avoid water stagnation in order to prevent breeding of mosquitoes, especially *Aedes*.

1.4 Scope of Study

As for the time scope, the first semester is focused on research and studying septic tanks design for properties at Manjung district. The problems regarding water stagnation that caused breeding mosquitoes are going to be explored details. Instead of that, this project will also cover the gathering of information and data regarding reported dengue cases in Manjung especially in Sitiawan and Kg. Koh. The project will be performed in the form of laboratory experiments to do water quality test, analysis, and structure design. The scope for the second semester was focusing on mosquito surveillance at Taman Maju. Apart from it, a suitable maintenance program for the structure may be proposed to avoid water stagnation.

CHAPTER 2

LITERATURE REVIEW / THEORY

The practice of water and wastewater management in developing countries encounters more serious problems than those of developed countries because urban development occurs under more difficult socio-economic, technological and climatic conditions [4]. Developing countries experience accelerated urbanization without adequate investment in infrastructure, and against a background of poor public services for water treatment, collection and treatment of foul sewage, garbage collection, urban drainage, transport and health. Urban concentrations have environmental consequences in the form of urban flooding and pollution of water courses, soil and air.

Certain stagnation within the premises area can be observed in developing countries. The sanitary concept is further aggravated by the fact that in many cases it is poorly implemented through bad design, bad construction or deficient maintenance. In the housing area of developing country, it is common to see property drains that are badly positioned and blocked [5]. All of these contribute to inadequate drainage management and design.

2.1 Dengue Fever

Dengue fever is a type of arbovirus, which is short for arthropod-borne virus. The virus that causes dengue fever is carried by Aedes egypti mosquitoes, and is transmitted to humans through their bite. An organism that carries a disease, without actually developing the disease, is called a vector [6].

The risk for being bitten by a mosquito that is carrying dengue fever is higher in Africa, Southeast Asia and China, the Indian subcontinent, the Middle East, South and Central America, the Caribbean Islands, Australia, and the South and Central Pacific [6]. Dengue fever is considered "endemic" to certain regions, which means it is native to, or naturally occurring, in these areas. Dengue fever is more likely to occur during or shortly after the rainy season, when the mosquito population is larger.

In Malaysia, dengue hemorrhagic fever (DHF), though endemic in the sixties emerged as a major public health problem from 1973 onwards. The incidence rate of DHF which was 10.1 per 100,000 in 1973 has fallen down to 1.9 per 100,000 in 1987 with a mean case fatality rate of 6.4 per 100 persons. Dengue hemorrhagic fever is predominantly an urban disease in Malaysia with a mean incidence rate of 5.3 cases per 100,000 as opposed to 1.2 cases per 100,000 being reported from rural areas. The mean overall incidence of deaths in the urban area is 0.5 compared to 0.1 per 100,000 for rural areas [7].

In the late 1950s, the disease manifested itself in a hemorrhagic form that is very often fatal [8]. Dengue fever is caused by a virus belonging to a group of viruses known as Arbor viruses, introduced into the body by the bite of two species of mosquitoes, *Aedes aegypti* and *Aedes albopictus* [8]. The mosquitoes, particularly *Aedes aegypti*, breed in relatively clear water in and around urban areas. Dengue fever (DF) and dengue hemorrhagic fever (DHF) have been the most common mosquito-borne diseases in urban areas of Malaysia.

The housing area, Taman Maju which is under the jurisdiction of Perak Tengah district has shown sudden increased in dengue outbreak recently. Table 2.1 shows statistical data on dengue prevention produce by Vector Borne Disease Control Unit of Perak Tengah district for the year 2005.

Table 2.1 Output specification for dengue prevention

No.	DENGUE PREVENTION	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	TOTAL	TARGET	%
1	Reported dengue case	15	35	10	1	1	1	4	3	1	4	4	7	86	203	42.4%
2	Inspected dengue case	15	35	10	1	1	1	4	3	1	4	4	7	86	203	42.4%
3	Positive case	10	29	2	0	1	0	1	2	0	0	1	1	47	86	54.7%
4	Inspected premises for aedes breeding place	2257	2291	2510	2321	2271	2366	2744	2822	2090	2173	1725	1396	26,966	50,000	53.9%
5	Sprayed premises	1345	1213	857	652	111	319	239	787	713	1104	985	1188	9513	50,000	19.0%
6	Positive premises	8	3	7	10	4	0	3	0	1	0	1	2	39	345	11.3%
7	Issued notice	4	1	5	1	2	0	1	0	1	0	1	0	16	40	40.0%
8	Court action	0	0	0	0	0	0	0	0	0	0	0	0	0	5	0.0%
9	Issued compound	2	0	3	8	2	0	3	0	0	0	0	2	20	300	6.7%

Source: Vector Borne Disease Control Unit in Perak Tengah District, 2005

At present there is no effective drug for the treatment for both sicknesses, only for symptomatic treatments. The two species of Aedes mosquitoes, the carrier of dengue fever and dengue haemorrhagic fever, breed in relatively clear water. Consequently, the control of the disease by Department of Health centers on the destruction of breeding containers. A study in Penang showed that more schools harbour Aedes mosquitoes in their compounds than residential premises and shophouses [9]. Container management is perceived as the best and practical approach to check the breeding of the Aedes mosquitoes at source but the public education and cooperation essential for the success of the program are sorely lacking. The use of Abate, synthetic insecticide sand granules, has been equally unsuccessful. After more than 30 years of usage, Abate has been shown to have decreased in its effectiveness with suspected resistance being developed in the Aedes mosquitoes. The toxicity to non-target organisms and the effects of chemical larviciding on water quality have not been duly considered. As for the thermal fogging sprays used, public suspicion of the method is widespread.

2.2 *Aedes Aegypti*

Mosquitoes breed in standing water, that is, any body of water without turbulent flow. They do best in weedy ponds and stagnant water that collects in ditches, fields, or containers and they require water for just 4 to 14 days to mature (but sometimes longer in cold weather).

Aedes aegypti (Linneo 1762) is one of the most studied culicid species because of its frequent use in experimental research, its presence in houses and its importance as vector of urban yellow fever and dengue (Tinker 1964). However, the ecology of this mosquito remains largely misunderstood (Rodhain 1996) and a more comprehensive knowledge of *Ae. aegypti* biology is needed to predict and explain dengue outbreaks (Fernandez-Salas & Flores-Leal 1995).

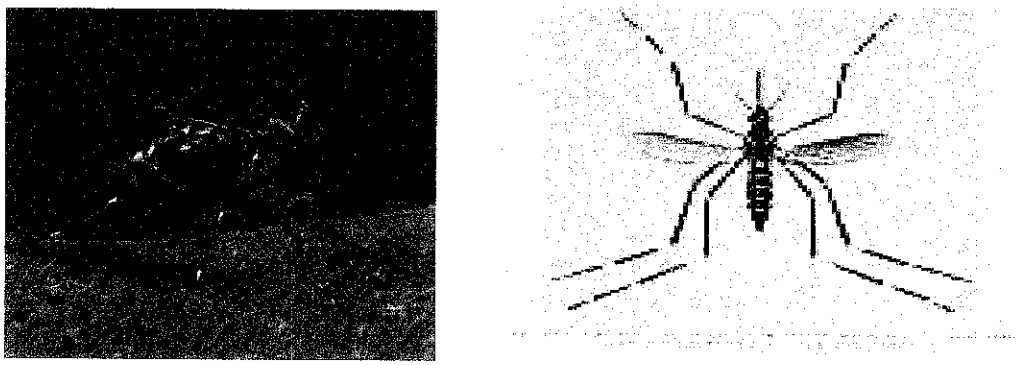


Figure 2.1 *Aedes aegypti*

Mosquitoes have four distinct life stages as seen in the illustration in Figure 2.2, with the first three stages (egg- larva-pupa) being spent in the water [10]. An adult female lays about 150-200 eggs in clusters called rafts, which float on the surface of the water until they hatch in about one to two days. Females usually prefer to lay eggs in standing, polluted water, such as sewage, street drainage, septic tanks, industrial wastes and backyard sources that include swimming pools, ornamental ponds, cooler drain-water and fouled water in containers. A wide variety of other water sources may also be infested with the aquatic stages of this common mosquito.

The eggs hatch into larvae (wigglers), which then feed on small organic particles and microorganisms in the water. At the end of the larval stage, the mosquito molts and becomes the aquatic pupa (tumbler). The pupa is active only if disturbed, for this is the "resting" stage where the larval form is transformed into the adult. This takes about two days during which time feeding does not occur. When the transformation is completed, the new adult splits the pupal skin and emerges. Under optimum conditions development from egg to adult takes about a week. However, all mosquito developmental times are dependent on the temperature of the water in which they mature.

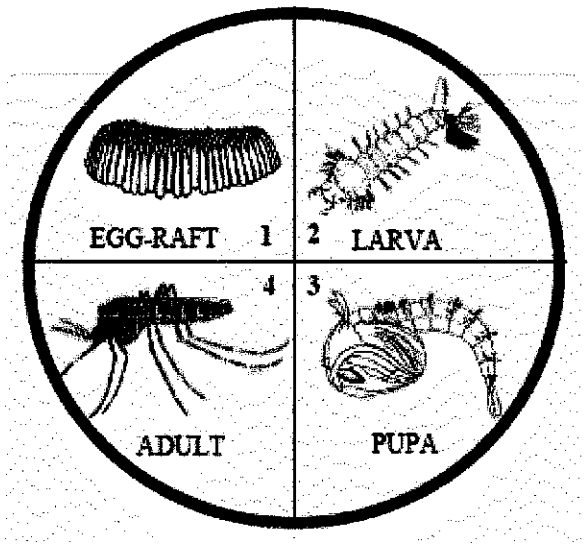


Figure 2.2 Mosquito life cycle

2.3 Septic Tank

Wastewater or sewage is generated through the use of toilets, bathrooms, sinks, showers and bathtubs, kitchen sinks, garbage disposals, dishwashers and washing machines. It contains dissolved organic and inorganic materials, suspended and settleable solids, and microorganisms, including bacteria and viruses. Majority of homes utilizes septic tanks to remove solids and greases for wastewater disposal. It is watertight container which provides anaerobic digestion of the solids, and storage of the sludge and scum. Septic tanks do not remove large numbers of bacteria and viruses.

The septic system is a natural method of treatment and disposal of household wastes. It works by allowing wastewater to separate into layers and begin the process of decomposition. Bacteria which are naturally present in all septic systems begin to digest the solids that have settled to the bottom of the tank. It will transform up to 50 percent of these solids into liquids and gases. When liquids within the tank rise to the level of the outflow pipe, they enter the drainage system.

Septic tanks are constructed of concrete, bricks, clay, or fiberglass. Baffles are placed within the tank to improve solids settling and prevent the scum layer of

lightweight solids, fats and greases from floating out of the tank with the effluent. The settled solids are biologically digested by bacteria which live in environments without air (anaerobic bacteria). Some of the products of anaerobic digestion are gases, including methane, carbon dioxide, and hydrogen sulfide, which has an odor similar to that of rotten eggs. The gases are vented from the septic tank through the household plumbing vents. Inorganic and non-biodegradable materials cannot be digested by the microorganisms in the septic tank, and accumulate in the sludge or scum layers. The sludge and scum layers must be removed periodically to prevent the accumulated solids and greases from flowing into the soil absorption system and clogging the soil pores.

Septic systems protect human health and the environment by safely recycling wastewater back into the natural environment. Septic systems treat wastewater as well as, or better than, municipal treatment systems at a reasonable cost when properly designed, installed, operated, and maintained. Federal, state, and local regulation of on-site systems focuses on proper treatment of sewage to protect citizens, communities, and the environment.

Inlet and outlet baffles trap the floating solids in the tank. Inspection pipes allow monitoring of the tank and the manhole facilitates cleaning. The size of the septic tank is based on the home's potential water use volume and the type of appliances used. In aerobic tank systems, pumps are necessary to deliver air to the tank.

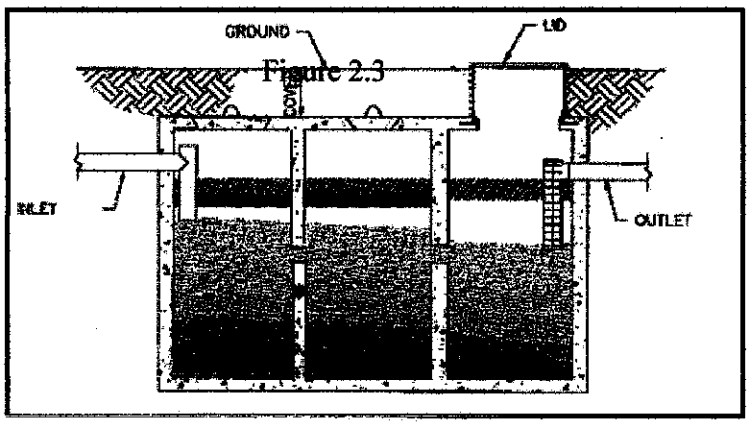


Figure 2.3 Compartment of an individual septic tank

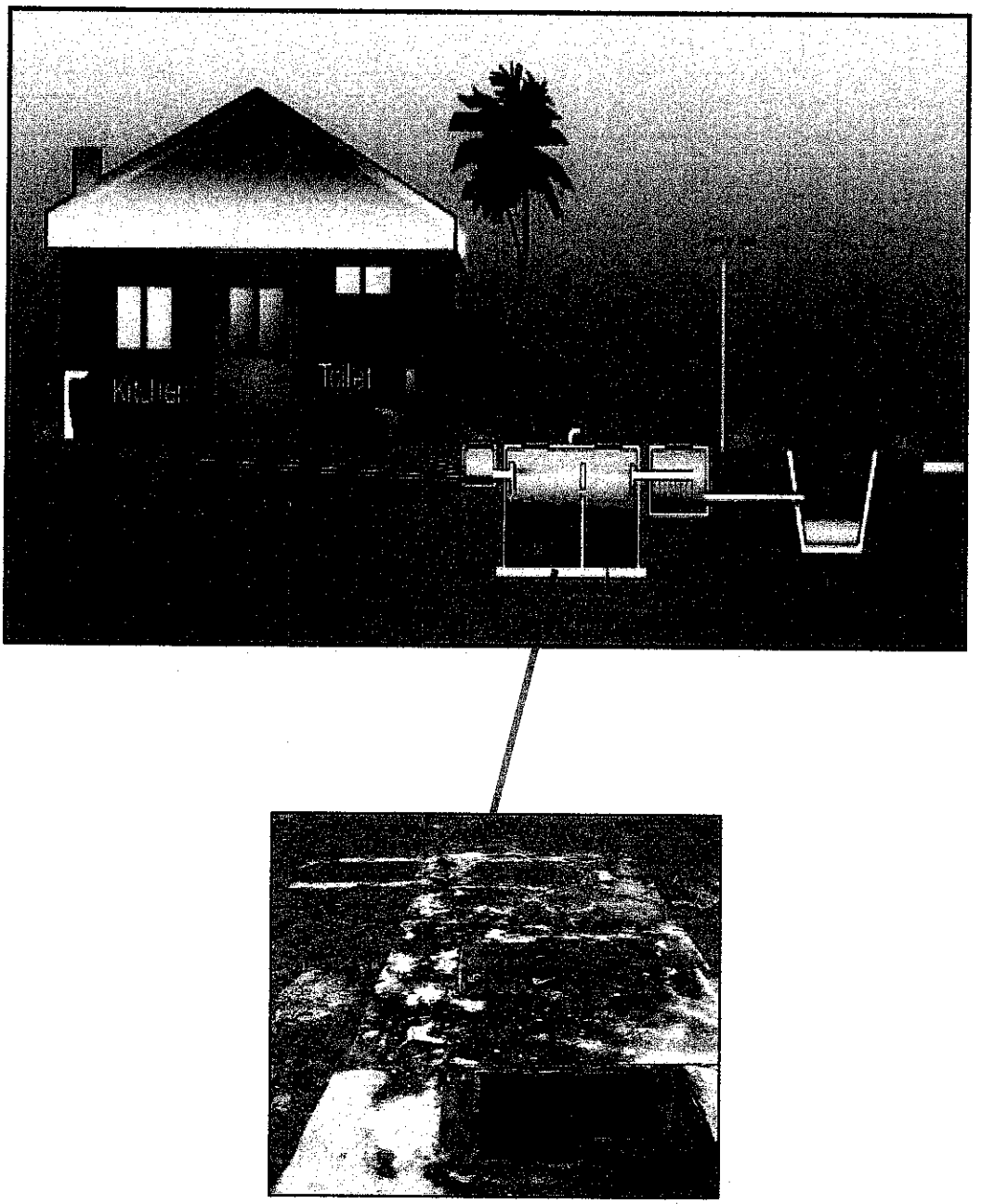


Figure 2.4 Septic tank in Taman Maju

Septic tank mosquitoes in Abia State University Okigwe, south-eastern Nigeria were studied using exit traps between November 1988 and April 1989 [11]. The results were revealing and striking. Apart from the common septic tank mosquitoes, Culex p. quinquefasciatus, Cu. cinereus and Aedes aegypti, which have been previously commonly found breeding in ammonia and nitrate-rich waters of latrines and septic tanks, the other species, Cu. horridus, Cu. tigripes and Aedes vittatus, have not been

commonly reported as colonizing septic tanks in Nigeria. Three out of these six mosquito species observed are vectors of human diseases: Aedes aegypti and Aedes vittatus are vectors of Yellow fever and Cu. p. quinquefasciatus is a potential vector of Bancroftian filariasis and a world-wide vector of various arboviruses [11]. The fact that these mosquito vectors are able to breed in highly polluted waters of septic tanks during the harsh dry months when most surface water bodies are dry is epidemiologically important. The breeding of these mosquito vectors of human diseases around human dwellings indicates an intense man-vector contact creating a high level risk to the urban population. The public health implications of this urbanization/modernization problem and solutions are discussed.

In Kochi, west coast of India, most of the 1.2 millions septic tanks support mosquito breeding [12]. Open vent pipes, open outlet pipes and damaged slabs make the septic tanks conducive for mosquito entry and breeding. The outlet pipes are either connected to open drains or open to form a pool, which support profuse breeding of mosquitoes. This is a technical problem as the liquid portion of the effluent needs to be let out, making such outlet pipes inevitable. When such pipes are diverted to the open ground, mosquitogenic pools are created. Regular spraying is required to monitor such situations. The outlet pipes also serve as entry and exit points for the mosquitoes. Attaching a water seal with a U tube device as shown in Figure 2.5 can serve as a permanent solution. To protect this device, a cover may be constructed as an extension structure. These water seals may also serve as the source for oviposition of mosquitoes. But, the resulting larvae will automatically be flushed out, either into the pool or drain where larvicidal spraying is a routine activity.

Another simple, inexpensive method is to cover the opening of the outlet pipe with mosquito net (Figure 2.6). As there are chances of this net getting damaged or removed, it needs to be replenished. The vent pipehood of septic tanks also serves as another entry point for the mosquitoes. These hoods should be covered with mosquito net. The hood for the vent pipes may be designed with small holes making it mosquito proof. Septic tanks with broken slabs pave the way for the entry of mosquitoes. Cracks and cervices resulting from improper covering also create mosquitogenic conditions. These defects can be rectified by replacing the damaged slabs with new, reasonably thick slabs or the cracks and cervices can be plastered

with cement. The concerned households should be motivated to be responsible to carry out these repairs themselves.

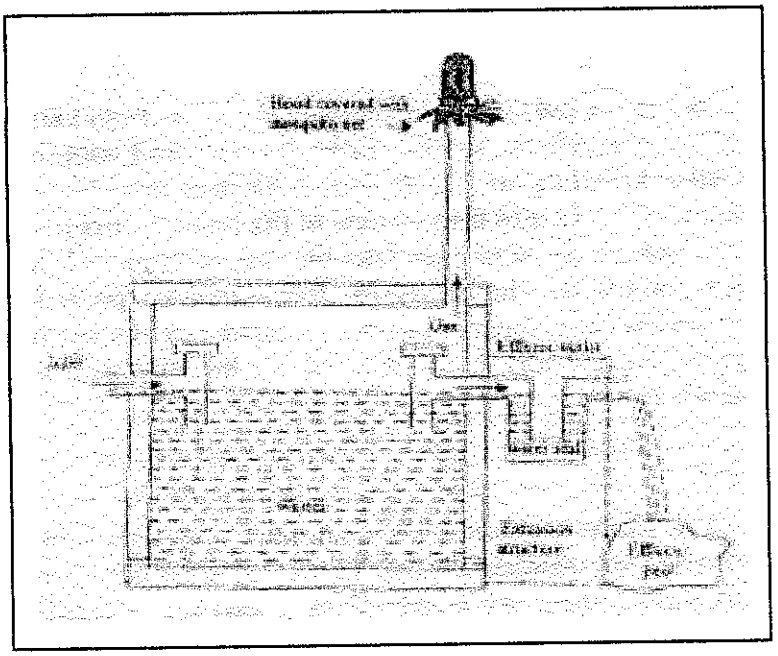


Figure 2.5 Attaching water seal with U tube device

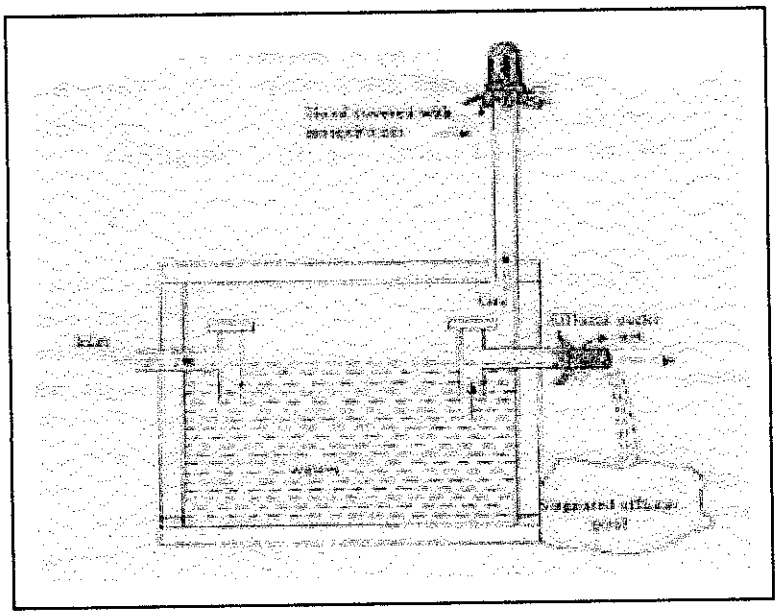


Figure 2.6 Covering the opening outlet pipe with mosquito net

The vent pipehood of septic tanks as shown in Figure 2.7 also serves as another entry point for the mosquitoes [13]. These hoods should be covered with mosquito net. The hood for the vent pipes may be designed with small holes making it mosquito proof.

Figure 2.7 Ventilation pipe

CHAPTER 3

METHODOLOGY

3.1 Data Collection

The study requires the author to gather some data on dengue cases from Health Department of Manjung District and Health Department of Perak Tengah District. In addition to that, this study focused on field data collection to verify the presence of mosquitoes in septic tank and also on the existing maintenance done by the local authority to prevent further water stagnation.

3.2 Study Area

Two different locations had been chosen in order to accomplish for this project. For the first semester, the study is aimed to achieve its objectives in Manjung district while for the second semester; the study is then preceded in Taman Maju.

3.2.1 Manjung

The research study is focused at Manjung district. By the end of 2004, it was estimated that there were 750 cases of dengue infection, which some of them resulting in deaths in Manjung. As suggested by Mr Mohan, the Health Officer from Health Department of Perak Tengah District, Sitiawan and Kg. Koh, which is part of Manjung district have been selected as the areas that are going to be studied for the final year project. Taman Megah Tiga and Taman Mas Kg Kok in Sitiawan are situated in the district of Manjung, Perak Darul Ridzuan. The surface area of this residential area is flat and suitable for agriculture and many others activity. It is located near the geographic centre of the district, in a crowded neighbourhood of high building and intense commercial activity.

Epidemiological investigations demonstrate that there had been dengue cases in this area. Aedes is the main vector of dengue fever. Mosquito breeding habitats most identified in a premise are septic tanks, gutters, drains and also miscellaneous man made containers. This study provides detail analysis in terms of poor drainage system design especially in septic tank that leads to water stagnation. It is important to identify and correct drainage problems when they occur. Before starting any drainage improvements, all parts of the current drainage system are fully identified.

3.2.2 Taman Maju

The second study is done at residential area in Taman Maju, administrated by Perak Tengah Local Authority. It is located about 5 km from UTP. This area has been identified as having high density of mosquito population recently. According to Mr Haidzir, the Environment Health Officer from Health Department of Perak Tengah District, septic tank do contributes as one of the engineering structures that become the source of mosquitoes breeding apart from the drains, marshy lands and miscellaneous household domestic containers which can be found in that area.

The Taman Maju area has fall under second priority in Perak Tengah circumference. The level of priority is determined by the significance of dengue case in that area. It illustrates on how many times an area should be inspected through out the year:

- Priority 1 - inspection is done monthly
- Priority 2 - inspection is done every 3 month
- Priority 3 - inspection is done twice per year

3.3 Preliminary Study

In fulfilling the requirement to proof the presence of mosquitoes in septic tank, about 20 various septic tanks within the residential area in Taman Maju were accessed. Septic tanks that contain *aedes* larva are considered as positive. In order to identify septic tanks that are positive for *aedes aegypti*, the monitoring of breeding sites was

carried out. Sampling of water from septic tank was made to show that the tank contains larva. The water was taken by using a pot carefully. Then the larva was identified whether it is *aedes aegypti* or not by using microscope.

The total 20 septic tank were taken from four different rows of houses. Each row comprises of 5 houses and the rows are Lorong Maju Setia 4, Lorong Maju Setia 6, Lorong Maju Setia 9, and Lorong Maju Setia 10.

3.4 Laboratory Water Analysis

The laboratory experiments were carried out at the Environmental Engineering Laboratory at Universiti Teknologi Petronas (UTP). The performance of each wastewater was evaluated by the determination of the effluent concentration and characteristics in terms of pH, COD, BOD_5, TSS, turbidity and temperatures.

Chemical and physical parameters of the effluent samples taken from the septic tank were analyzed according to the methods described in Standard Methods for the Examination of Water and Wastewater (American Public Health Association 1995) as shown in Table 3.1.

Table 3.1 Parameters and analytical methods

Parameters	Methods of analysis
pH	pH meter
Turbidity	Gravimetric method
BOD_5 (mg/l)	Standard Methods 5210
COD (mg/l)	Standard Methods 5220
TSS	Standard Methods 2540-D

For the purpose of this study, wastewater was taken from individual septic tank in residential area at Taman Megah Tiga and Taman Mas Kg Kok. This wastewater was used for all treatment units and stored at the Environmental Laboratory of Universiti

Teknologi Petronas. All wastewater sample parameters were based on 8 samples. The sources of the wastewater are presented in Table 3.2.

Table 3.2 Sources of the water sample during the research study

Water Sample	Location	Type of house
1	Taman Megah Tiga	Abandoned
2	Taman Mas Kg Kok	Occupied
3	Taman Megah Tiga	Abandoned
4	Taman Megah Tiga	Abandoned
5	Taman Mas Kg Kok	Occupied
6	Taman Mas Kg Kok	Occupied
7	Taman Mas Kg Kok	Occupied
8	Taman Mas Kg Kok	Abandoned

3.5 Ovitrap Survey

Apart from that, the mosquito larva's populations will also be counted to determine the existing of them. As *Aedes* mosquito transmits dengue fever, the effective solution is to control the population of the mosquito by preventing it from further breeding. 'Ovitrap' has been introduced as a tool to monitor, detect and control *Aedes* populations. It can be used as quality assessment indicator for larva survey and to identify the effectiveness of any fogging activities that are implemented. The population of adult mosquitoes in the environment can be estimated by counting the number of eggs laid on the moist paddle. A sudden increase of mosquito population and changes in the species breeding (*Aedes aegypti* to *Aedes albopictus* or vice versa) can be detected.

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Field Work Activity

The author had gone through with field work as parts of activities in completing this project. The study areas are at Sitiawan and Kg Koh. Table 4.1 shows that by the end of year 2004, the area with high dengue cases is Ayer Tawar. The activities are related to the septic tank problems at selected residential area in Taman Megah Tiga, Sitiawan and Taman Mas, Kg. Kok, Manjung. However, for the time being, there has been a decreasing in reported dengue case due to the action taken by the local authority and health department to control the population of Aedes.

Table 4.1 Number of dengue fever cases recorded for Manjung District in 2004

Area	No. of Cases
Pantai Remis	8
Beruas	10
Ayer Tawar	150
KB Ayer Tawar	99
Simpang Lima	32
Pekan Gurney	74
Sitiawan	100
Kg. Koh	97
Seri Manjung	63
TLDM	89
Lumut	7
Pulau Pangkor	21

Source: Public Works Department of Manjung District

Pictures below illustrate the situation of the residential area at Taman Megah Tiga, Sitiawan.

Figure 4.1 The study area at Taman Megah Tiga, Sitiawan

Figure 4.2 Opening outlet pipe that provide access for the mosquitoes into septic tank

Figure 4.3 Photo shows the conventional septic tank with three compartments

Figure 4.4 Adult mosquitoes can be seen hanging on the septic tank wall when the cover was open

4.1.1 Measurement/ Dimension of Septic System

There are mainly two types of sewerage systems in Malaysia. The premises' sewerage systems are either connected to a public sewage treatment plant or have individual septic tanks. Indah Water Consortium (IWK) is mainly responsible for operating and maintaining the public sewage treatment plants and network of underground sewerage pipelines as well as providing desludging services to individual septic tanks.

Malaysia's most common form of sewerage system is the individual septic tank (IST) [23]. Those premises in Taman Megah Tiga and Taman Mas Kg Kok with a proper individual septic tank (Malaysian Standards - MS 1228) has 3 rectangular concrete or metal covers and is usually located at the compound either at the side, rear or front. The septic tank only provides partial treatment of the sewage that flows into it and needs to be desludged on a regular basis, approximately once in two years, to ensure that it functions efficiently [23]. IWK provides this important and mandatory scheduled desludging service.

Each septic tank incorporates three main distribution boxes. Measurement conducted in this study indicated the dimension of the septic tank is 150 cm for the width and 607 cm for the length. The opening size for each distribution box is 51 cm x 38 cm. Figures below show septic tank and the distribution box. When the effluent leaves the septic tank, it is sent to the distribution box (D-box). The D-box usually has a

single inlet (from the tank) and outlets leading to an individual leach line in the absorption area and another leading to the next D-box.

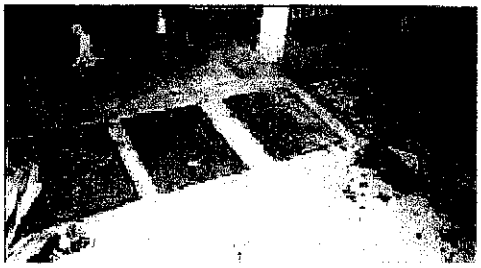


Figure 4.5 Photograph of a typical individual septic tank built according to Malaysian Standard

Most septic systems are conventional systems that use gravity to distribute the effluent from the tank. Septic systems cannot dispose of all the material that enters the system. Solids that are not broken down by bacteria begin to accumulate in the septic tank and eventually it needs to be removed. The most common reason of system failure that was identified in case study area is not having these solids removed on a regular basis. When the holding tank is not pumped out frequently enough, the solids can enter the pipes leading to and from the tank.

4.2 Laboratory Water Analysis

As the wastewater passes through the tank, its characteristics change and different bacterial cultures predominate as the bacteria break down complex proteins, carbohydrates, and fats. The objective of this water analysis is to determine the pH, temperature, turbidity, TSS, BOD, and COD of the treated water and to relate it to mosquito breeding environment.

4.2.1 Temperature, pH and Turbidity

Sampling was done to determine the temperature, pH, and turbidity of each sample. Proper sampling is important in order to maintain the integrity of the sample during water analyses. Temperature indicates the amount of heat that the water experiences on that time. Most of the water sample have pH value higher than 7. Turbidity is the measure of cloudiness of the water. It is used to indicate water quality and high presence of suspended solid will reduces the water clarity. Turbidity obtained from each of the sample is different since they come from various sources. Some of them might be quiet cloudy since the sources of water are from houses with households activities occur there. For abandoned house, it is observed to result in clearer water.

Table 4.2 Values of pH, temperature and turbidity for different water sample

Water characteristic	pH	Temperature (°C)	Turbidity (NTU)
Sample 1	8.973	29.4	1.40
Sample 2	7.475	30.2	39.8
Sample 3	7.546	19.8	3.56
Sample 4	7.488	20.4	5.57
Sample 5	7.230	20.2	45.7
Sample 6	7.486	19.9	10.3
Sample 7	7.506	20.3	5.03
Sample 8	8.175	20.2	1.08

4.2.2 Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) is an indirect indicator of the amount of the organic matter present in the waste water. In another terms, BOD is the amount of oxygen used by bacteria to degrade the organic matter present in the wastewater. This experiment is done purposely to determine the BOD for wastewater sample taken from septic tank in residential area. Eight samples of wastewater have been taken at different time and place. Basically, the results obtained throughout this experiment may have some error since there are several problems arise such as delaying the time for water sample preservation. Once a sample is taken, the constituents of the sample should be maintained in the same condition as when collected. When it is not possible to analyze collected samples immediately, samples should be preserved by using cooling method at 4°C for 48 hours. Biological, chemical, and physical activity must be kept to a minimum. BOD_5 is a very common perimeter used in the control of treated wastewater effluent quality. This test is a simulation of the microbial processes occurring in water contaminated with organic compound. It measures the dissolved oxygen consumed in a sample diluted in a 300 ml bottle during a specified incubation period (usually 5 days at a temperature of 20° C in darkness). Measured amounts of wastewater sample are diluted with prepared water containing nutrients and DO.

Table 4.3 BOD_5 value for different water sample from septic tank

Sample	Volume (ml)	Initial DO	Final DO	DO Depletion	BOD
Blank		7.00	6.56	0.44	0.44
1	10	8.24	8.00	0.24	7.2
2	10	8.19	7.66	0.53	15.9
3	10	7.21	6.18	1.03	30.9
4	10	7.22	6.21	1.01	30.3
5	10	7.08	5.98	1.10	33
6	10	7.18	6.04	1.14	34.2
7	10	7.08	5.90	1.18	35.4
8	10	7.20	6.58	0.62	18.6

4.2.3 Chemical Oxygen Demand (COD)

The COD test measures the equivalent of the organic matter that can be oxidized by a strong chemical oxidizing agent (potassium dichromate) in an acidic medium. It requires a shorter time which is approximately 3 hours compared to 5 days for BOD test.

The samples for the experiment were taken from eights different septic tank. Some of them come from occupied house while the others are from abandoned house. Through observation, samples from occupied house will give a higher value of COD rather than samples from abandoned house. Sample 2, 5, 6 and 7 are from septic tank with human activity occurred there. Wastewater quality is influenced by the contaminants discharged into it which resulting from human and household activities.

Table 4.4 COD value for different water sample from septic tank

Sample	COD reading(mg/L)			Average reading(mg/L)
	Reading 1	Reading 2	Reading 3	
Blank				0
1	13	8	12	11
2	45	56	58	53
3	84	46	64	65
4	51	52	60	54
5	136	140	127	134
6	58	42	57	52
7	58	63	78	66
8	6	11	10	9

4.2.4 Total Suspended Solid (TSS)

The most important physical characteristic of wastewater is its total solids content, which is composed of floating matter, matter in suspension, colloidal matter, and matter in solution. Therefore, this test is done to calculate the non-filterable residue in water using gravimetric method. The obtained result is as follow:

Table 4.5 TSS value for different water sample from septic tank

Sample	Sample size (ml)	Weight of pan + filter paper before drying (mg)	Weight of pan + filter paper after drying (mg)	TSS (mg/L)	Average TSS (mg/L)
1 (i)	100	1.2759	1.4856	2.097	
(ii)	100	1.3016	1.4932	1.916	
(iii)	100	1.3171	1.5088	1.917	1.977
2 (i)	100	1.3671	1.5073	1.402	
(ii)	100	1.3306	1.5502	2.196	
(iii)	100	1.2704	1.4461	1.757	1.785
3 (i)	100	1.3525	1.5288	1.763	
(ii)	100	1.3245	1.5027	1.782	
(iii)	100	1.3292	1.4954	1.662	1.736
4 (i)	100	1.3499	1.5000	1.501	
(ii)	100	1.3107	1.4796	1.689	
(iii)	100	1.3599	1.5413	1.814	1.668
5 (i)	100	1.3311	1.4950	1.639	
(ii)	100	1.3322	1.4912	1.590	
(iii)	100	1.2698	1.4464	1.766	1.665
6 (i)	100	1.3814	1.5172	1.358	
(ii)	100	1.3341	1.4783	1.442	
(iii)	100	1.3373	1.4958	1.585	1.462
7 (i)	100	1.3441	1.5079	1.638	
(ii)	100	1.3174	1.4453	1.279	
(iii)	100	1.3314	1.5025	1.711	1.543
8 (i)	100	1.2614	1.5183	2.569	
(ii)	100	1.3034	1.4232	1.198	
(iii)	100	1.2681	1.4502	1.821	1.863

4.3 Study Area: Taman Maju

A survey was conducted to characterize the mosquito fauna in septic tank in residential with emphasis on *Aedes aegypty*, and to determine the prevalence of mosquito-positive tanks to obtain background information for a source reduction program. The result of the mosquito surveillance is shown in Table 4.6 below. Lorong Maju Setia 9 was identified as having the most breeding septic tank compared with another three alleys.

Table 4.6 Result of mosquito surveillance in Taman Maju

Alley	Inspected septic tank	Septic tank contain larva	Larva identified as aedes	Larva identified as non aedes
Lorong Maju Setia 4	5	2	2	0
Lorong Maju Setia 6	5	3	2	1
Lorong Maju Setia 9	5	4	3	1
Lorong Maju Setia 10	5	3	1	2
Total	20	12	8	4

Twenty septic tanks were inspected to determine the types of mosquito. Throughout the septic tanks examined, twelve of them (60%) are found positive of contained larva. Others were found free from larva.

Of the positive septic tank, 66.67% or eight tanks contained *aedes aegypti* larvae. The other four tanks were recognized as having *culex pipie. Culex pipiens* or called as "house mosquito" is commonly develops in small containers around the home. It shows great skill in finding ways to get into the house where it feeds on the occupants at night. It also occurs in containers and drains, in polluted waters, and will feed out-of-doors at night.

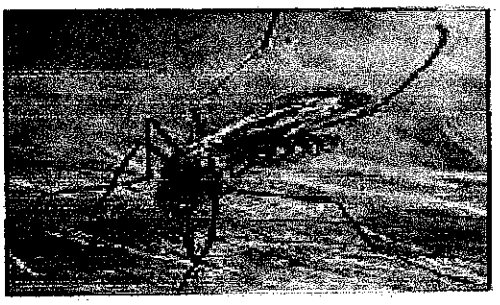


Figure 4.6 *Culex pipiens*

The population index of *aedes* = No of septic tank contain *aedes* larva X 100%
No of inspected septic tank

$$= \frac{8}{20} \times 100\%$$

$$= 40\%$$

Population index of 40 % indicates that Taman Maju is exposed to dengue occurrence. Therefore preventative measure should be taken to control the larviciding from the source of breeding mosquito.

4.4 Control Method

4.4.1 Ovitrap

The ovitrap is made up of a plastic bottle painted up with black colour. The black colour of ovitrap attracts female mosquitoes to lay their eggs. When the eggs hatch and develop into adults, they cannot fly out of the device and die inside the trap. The ovitrap is left for one week, and after that the results can be obtained to count for the Aedes population. A paddle that is made from wooden stick or paper with rough surface is placed in the ovitrap to provide place for the mosquito to lay eggs. Figure 4.7 below shows the ovitrap that is used to determine the ovitrap index.

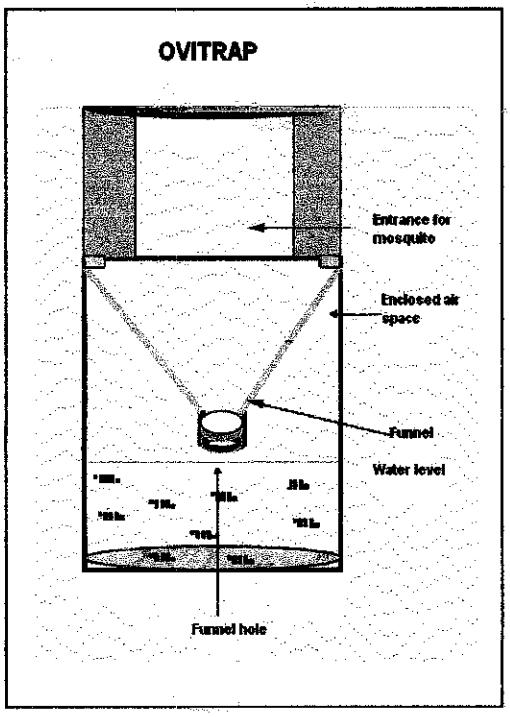
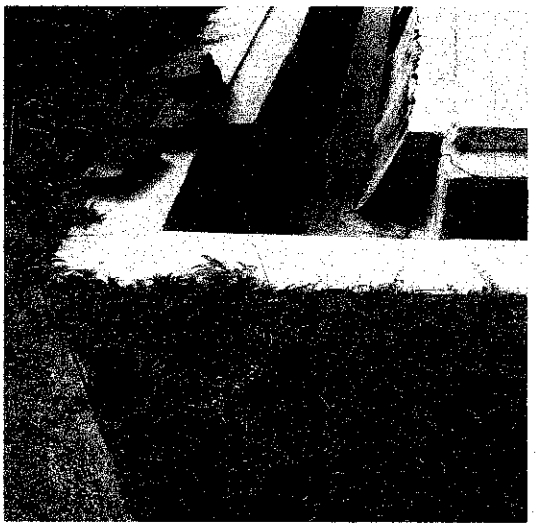


Figure 4.7 Ovitrap

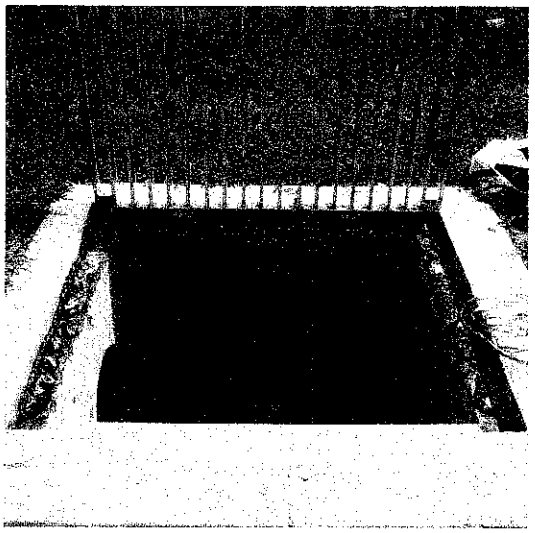
Ovitrap survey has been done in UTP area to detect the population of Aedes at UTP. 30 different places are arbitrarily selected to locate the ovitraps. 15 ovitraps are placed around village 4 residential college and they are discreetly put mainly along the corridors and away from the places where they are likely to be knocked over. Another 15 ovitraps are located along the main roads near the mosque, new academic building, petrol station, and Pocket C building areas. These ovitraps are placed in suitable place such as to the nearest engineering structures with high tendency of mosquito breeding (e.g sump, drain, manhole, sluice chamber, water hydrant and septic tank) and also at miscellaneous man made containers. Pictures attached in Figure 4.8 show the location of ovitraps survey done in UTP. The result then is presented in Table 4.7 below.

Due to the similarities of the two environments in UTP and Taman Maju and within the same circumference of Perak Tengah District, the conducted ovitrap study in UTP can also be applied in Taman Maju, in which it would produce a similar result.

Ovitrap that is made from plastic bottle with black paint



Ovitrap is placed at the corner of sump drain



Ovitap that is tied to the grating at sump

Ovitrap at water hydrant

Figure 4.8 Location of the ovitrap in UTP

Table 4.7 Results for ovitrap survey

Ovitrap conditions	Amount	
	Residential college	**Along main roads**
Ovitrap that contains larva inside	7	5
Ovitrap without larva	8	10

Throughout the surveys, it is observed that a total of 12 ovitraps that contain mosquito eggs. The eggs can be identified by the black spots on the wooden stick. The ovitrap index for UTP is calculated using the formula below:

$$\textbf{Ovitrap Index (OI)} = \frac{\textbf{No. of ovitrap containing larvae}}{\textbf{Total No. of ovitrap}} \times 100\%$$

Therefore:

$$\textbf{OI for UTP} = \frac{12}{30} \times 100\% = 40\%$$

It is clearly state in Ovitrap Survey, Vector Bourne Disease Control Plan by Perak Health Department that from research done by Institute of Medical Research (IMR), if the ovitrap index (OI) = 10% or above, the study area is exposed to risk of dengue outbreak and the necessary action should be taken. With 40% of OI, this result shows that UTP has become one of the hot spot of mosquito breeding place and it clarify the reason of having fogging activity in UTP especially at residential colleges. The bad weather conditions as the project was implemented during raining season really make an adverse impact since this will reduced the effectiveness of this ovitrap to monitor and detect mosquito populations. Apart from that, there is also technical problem arise such as the ovitraps were thrown by the cleaner.

4.4.2 Abate-1-SG

The Health Office of Manjung District has also come out with solution in preventing mosquito breeding. According to the Health Officer, Mr Khairi, it is advisable to use a chemical substance known as 'Abate-1-SG' to prevent larva from breeding in the septic tank. The recommended dosage should be 10gm 'Abate-1-SG' for every 90 liter of water. This Abate is immersed into the septic tank. This project needs full cooperation and involvement from the resident itself in order to implement it with successful. It cannot be done alone, as it requires help of the community at large. Through out the observation, there is less public awareness among resident in keeping the surrounding area of their house clean.

4.4.3. Air lift pump

As shown by the result, some modification on the existing design of the conventional septic tank should be done. Throughout the assessment that has been done in Taman Maju and Manjung, it is comprehensible that the failure of pump system to force the water out to the drain become the reason of excessive water stagnates higher than usual effluent level. It then provides access through the connected open outlet pipe, which make the septic tanks conducive for mosquito entry and breeding. Furthermore, the probability of mosquito breeding in the dark place is high as the tank prevents incoming sun light from entering the structure.

Air lift system of water pumping can be introduced as one way of modifying the structure. Air lift operates by the injection of compressed air into the water inside, at a point below the water level in the tank. The injection of the air results in a continuously mixture of air bubbles and incoming wastewater, which being lighter in weight than water outside the discharge pipe, forces the air and water mixture up.

The system will also increase amount of oxygen that can be supplied for water creatures' use. Apart from that, it provides the basic aerobic treatment process involves providing a suitable oxygen rich environment for organisms that can reduce the organic portion of the waste into carbon dioxide and water in the presence of oxygen.

This cleansing bioprocess continues as the bacterial colony is supplied with food (incoming waste) and oxygen (the air). All organic materials, such as proteins, carbohydrates and lipids are degraded by the biomass into simple carbon dioxide and water. A venting pipe allows for the release of air and non-harmful CO_2 created by the process. This can help to treat wastewater in a natural process ultimately. The use of a mechanism to inject and circulate air inside the treatment tank might be able to achieve better effluent quality.

CHAPTER 5

CONCLUSION

As a conclusion, it is very important for a civil designer to review the designs of septic tanks and other drainage systems as a bad design system will contribute to water stagnation problems. A systematic town planning will incorporates several of elements in which drainage system is a part of it. Therefore, the failure of septic tanks must be avoided.

Results of water quality analysis indicates that the effluents wastewater for septic tanks are clear with BOD below 50 mg/ L which comply the standard value provided. This clean water is capable to become breeding ground of mosquitoes. However the control of mosquito by abating is found effective and most of the septic tanks in Manjung are generally free from mosquito after abating process.

During inspection on proving the mosquito presence in septic tank, the population index is 40 %. The high percentage indicates that Taman Maju is exposed to dengue outbreak thus, preventative measures need to be taken immediately.

RECOMMENDATION

Outbreaks of insect-borne disease won't occur if the number of insects available is too small to support an epidemic. Mosquito Control Districts' surveillance and control programs should aim at keeping vector insect numbers near populated areas below these critical levels. Success or failure in mosquito control hinges on accurate intelligence. Activities of the Mosquito Abatement Districts are almost all based on their day-to-day knowledge of local larval breeding sources. They know that source reduction is the single most important factor in controling biting insect pests and limiting the spread of mosquito-borne disease.

Advance research and development should be conducted on how to improve the structure design of septic tank to avoid wastewater from further more stagnates.

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