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ASSESSMENT OF WATER QUALITY STATUS OF SUNGAI GALING, KUANTAN PAHANG

NURAISHAH BINTI ABU

Report submitted in partial fulfilment of the requirements
For the award of the degree of
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ABSTRACT

The study of water quality at Galing River, Kuantan was conducted to determine the water quality status of the Galing River based on NWQS standard introduced by the Department of Environment (DOE) and Water Quality Index (WQI). In this study, five stations were selected for sampling and the standard methods were used for analysis. For sampling method, the water samples were taken twice a month starting on September until November. A total of eleven water quality parameters were assessed to obtain the quality at Galing River, which included physical, chemical and biological parameters. These parameters were pH, dissolved oxygen, temperature, turbidity, total suspended solids (TSS), biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia nitrogen, heavy metals test, total coliform and Escherichia coli. Based on results it is found that Galing River was classified under class IV according to the WQI, which the river water is suitable for irrigation only. The study revealed that sample station located in the commercial area showed the highest level of river pollution. River pollution was driven by the high content of contaminants and it was reduced the oxygen content in the water. Through the testing of heavy metals found that there was a high concentration of ferum and cadmium and it may affect the human health and environment. Precautions should be taken immediately by the authorities to control water pollution at Galing River and it should be supported by all parties.

ABSTRAK

Kajian mengenai kualiti air di Sungai Galing, Kuantan telah dijalankan untuk menentukan status kualiti air Sungai Galing berdasarkan NWQS, di mana standard yang diperkenalkan oleh Jabatan Alam Sekitar (JAS) dan Indeks Kualiti Air (WQI). Dalam kajian ini, lima buah stesen telah dipilih untuk pensampelan dan kaedah piawai digunakan untuk analisis. Bagi kaedah pensampelan, sampel air telah diambil sebanyak dua kali bermula pada September hingga November. Sejumlah sebelas parameter kualiti air telah dinilai untuk mendapatkan kualiti di Galing Sungai , termasuk fizikal, kimia dan parameter biologi. Parameter ini adalah pH, oksigen terlarut , suhu, kekeruhan, jumlah pepejal terampai (TSS), permintaan oksigen biokimia (BOD), permintaan oksigen kimia (COD) , ammonia nitrogen, ujian logam berat , jumlah koliform dan Escherichia coli. Berdasarkan keputusan didapati bahawa Galing Sungai dikelaskan di bawah kelas IV mengikut WQI , di mana air sungai hanya sesuai untuk pengairan sahaja. Kajian ini mendedahkan bahawa stesen sampel yang terletak di kawasan komersial menunjukkan tahap tertinggi pencemaran sungai. Pencemaran sungai didorong oleh kandungan yang tinggi bahan cemar dan ia mengurangkan kandungan oksigen dalam air. Melalui ujian logam berat mendapati bahawa terdapat kepekatan yang tinggi ferum dan cadmium dan ia boleh memberi kesan kepada kesihatan manusia dan alam sekitar. Langkah berjaga-jaga perlu diambil dengan segera oleh pihak berkuasa untuk mengawal pencemaran air di Sungai Galing dan ia perlu disokong oleh semua pihak.

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LIST OF ABBREVIATIONS

AN	Ammonia nitrogen
AAS	Atomic absorption spectrophotometer
BOD	Biochemical oxygen demand
Cd	Cadmium
COD	Chemical oxygen demand
DO	Dissolved oxygen
DOE	Department of Environment
DID	Department of Irrigation and Drainage
E- coli	Escherichia Coli
Fe	Ferum
Mn	Manganese
NWQS	National Water Quality Standard
Pd	Lead
ppm	Parts per million
TSS	Total suspended solids
WQI	Water Quality Index
Zn	Zinc

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Water is very important to us and is an invaluable natural resource. Water used for all things such as for drinking, producing food, source for generating electricity, irrigation and so on. In Malaysia, it has many areas of rivers and streams, but day by day the problem with rivers and surface water are increasing. This problem can affect our life because some of disease is causing from water. Clearly shows that the entire water problem is related with quality of water, much of rivers was threatens caused by human activities.

Malaysia is the one of country which is rich with the development, contributing much of manufacturing process. But, Malaysia was facing with problem of water polluted every year. In 2010, a total of 1,055 water quality monitoring stations located at 570 rivers were monitored. Out of these 1,055 monitoring stations, 527 (50%) were found to be clean, 417 (40%) slightly polluted and 111 (10%) polluted and the number of clean rivers decreased from 306 rivers in 2009 to 293, slightly polluted rivers decreased from 217 in 2009 to 203 while the number of polluted rivers increased to 74 from 54 according of Department of Environment (DOE, 2010).

Surface water resources have played important an important function throughout history in the development of human civilization. About one third of the drinking water requirement of the world is obtained from surface sources like rivers, canals and lakes. But, these sources serve as the best sinks for the discharge of domestic as well as industrial waste. Water pollution in Malaysia increase every day and most of the river cannot meet Class 1 according to Water Quality Index (WQI). This problem is lead to scarcity of clean water for drinking water purposes and effect human life and environment.

The source of water pollution can be divided into two which is by point sources and non- point sources. Point sources involved the wastewaters that are discharged from known sources at an identifiable point such as sewage treatment plants, manufacturing and agro industries also animal farm. The pollution happened at this source can be reduced by the proper wastewater treatment prior to discharge. Meanwhile, non-point sources are characterized by multiple discharge points such as agricultural runoff and surface runoff. The reduction if pollution for this source is by changing in land use practices.

1.2 PROBLEM STATEMENT

Department of Irrigation and Drainage was classified that the status water quality of Galing River was in Class IV based on DOE-WQI which is suitable for the irrigation only not suitable for drinking and fishery right now, the Galing River was identified as the dirties river in Pahang and it's happened because of the impact from the development increased day by day. The main reason contribute with river pollution at Galing River are industrial waste, unsystematic removal rubbish, improperly function of sewage treatment plants.

The number of polluted river was increased every year but the public still not realize the effect of river pollution to their life. The publics and government are conscious about the future of rivers. Our government was advised that we should protect the richest of water resource which important to our life and health.

Galing River serves important natural resources for the people living around the area. Basically, Galing River is the main drainage system of the eastern town of Kuantan and it has tributaries with Small Galing River. The main problem of river pollution faced right now at Big Galing River according the report from Department of Environment. There has lots of residential area, industries area along the river and also near with commercial centre at Kuantan. The upstream of the Galing River located at Semambu area meanwhile for the downstream located at Tanjung Api area.

Usually, the industrial area and commercial area will provide much of waste from the multiple activities such as at industrial area it contribute with the multiple kind of factory like a food and drink making, petrochemicals, oil and gas and so on. Meanwhile for the commercial area it involved with the economy activities such as shopping mall, hotels, building shop and other. All the activities will provide many of waste and it will discharge directly into the river, so the water quality of river will disturbed caused by all the wastes.

1.3 OBJECTIVES OF STUDY

The objectives of this study are listed below:

I. To determine the water quality status of the Galing River at Kuantan, Pahang

II. To classify the water quality based on Water Quality Index (DOE- WQI).

1.4 SCOPE OF STUDY

The scope of study for this research is at Galing River and located in Kuantan, Pahang. The purpose of this research is to identify the water quality satus of Galing River and classify the water quality based on Water Quality Index (DOE-WQI). The classifying of water quality based on WQI it will involve six parameters which are biochemical oxygen demand (BOD), chemical oxygen demand (COD), ammonia nitrogen (NH_3), total suspended solids, dissolved oxygen and pH. The sample will contribute with test which is it will divide into two tests, in – situ test and laboratory test. For in- situ test it will contribute with dissolved oxygen (DO), pH, temperature and turbidity. Laboratory test will included biochemical oxygen demand , chemical oxygen demand , ammonia nitrogen , total suspended solid, E-coli, total coliform and also heavy metal test. The quality of water will be classified follow the standard. In this research the standard for water quality determined from Department of Environment which is National Water Quality Standard (NWQS) and to classify the water is based on Water Quality Index. The quality of water can be known after done both of in-situ test and laboratory test.

1.5 SIGNIFICANT OF STUDY

The significant of this study are:

I. This research will help to know the water quality status of the Galing River based on Malaysia standard, National Water Quality Standard practiced by Department of Environment and classifying water quality based on Water Quality Index.

II. The research will proved the level of pollution of Galing River and identify the sources of the river pollution.

III. The data established from the research is helpful for the government in policy making.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Water is the essential part of the environment and living beings. The earth is like a water planet which is as 71% of the earth is covered with water. But, fresh water which is only 2.5% of all water is a scarce resource of the earth and again the water which is available for use is only 0.4% of total fresh water as like as tea spoon that represent the available water (Nasly et al., 2013). But, this little of fresh water was in danger situation because of the pollution of water and usually river water was threatened. The government should take precautions with this problem before it becomes worse.

Unlike distilled or deionized water all drinking water supplies will contain a range of dissolved chemical compounds. Even rainwater which is the purest water, found naturally it contains a wide range of ions and cations (Bao, 2010). Water is very important to us, its use in all human activities and is important to the public to get the clean and safe water. But to ensure its, the water resources need to care first because the cleanest of water is depending on the condition of water resources. Having good water quality is important for a healthy river and ecosystem. Several basic conditions must be to meet for aquatic life to thrive in the water. When these conditions are not optimal, species populations become stressed and when conditions are poor, organisms may die (DID, 2011).

2.2 RIVER POLLUTION IN MALAYSIA

Nowadays, Malaysia gets in trouble with the problem of river pollution which occurs every year even though it has the reduction of the percentage of Polluted River according to the report by the Department of Environment, the river water quality in terms of Water Quality Classification Index had shown a slight improvement in 2011. The percentage of clean rivers had increased from 51% (2010) to 59% in 2011. The percentage of polluted river had decreased from 13% in 2010 to 8% in 2011 (DOE, 2011). But the precaution must be considered to ensure that the cleanest of river water for the benefit to our next generation.

The water pollution is not only affects the water quality but also threats human health, economic development and social prosperity. River basins are highly vulnerable to pollution due to absorption and transportation of domestic, industrial and agricultural wastewater, therefore, it is significant to control the water pollution and to monitor the water quality (Reza and Singh, 2010). The large quantity of water resources available in the catchment but it's didn't guarantee adequate supply to all users because of the river pollution. The increasing of development will affect the normally changed the quality runoff within the catchment area, hence it affects the water quality of the river.

2.2.1 Source of River Pollution

The source of river pollution can be determined with two types which are point sources and non-point sources. Generally, wastewater from the residential, industrial and commercial areas causes the bad smell, especially in the garbage area and it will effects more the water quality of the river during raining season. Most of the sources of river pollution caused by the human activities and this is can't be denied even though some of the sources come from the natural sources. The government and public must take a precaution of this problem before it becomes worse and need hard way to solve it.

2.2.1.1 Point Source Pollution

The wastewater generates from the industrial area and sewage treatment plant classifies as a point source. Pollution from the point source is relatively easy to quantity, impacts can be directly evaluated (Cech, 2005, p.114). Some of industrial and sewage treatment plants connect directly to a water body and create point source pollution, but not all pipes create point source pollution. This term does not include agricultural storm water discharges and return flows from irrigated agriculture.

2.2.1.2 Non-Point Source Pollution

A non-point source generally results from land runoff, precipitation, atmospheric deposition, drainage, seepage or hydrologic modification. Usually it generated from the broad, diffuse source that can be very difficult to identify and quantify. Non-point sources pollutants enter the rivers, lakes and other water bodies through surface and groundwater movement (Cech, 2005, p.115).

States report that non-point source pollution is the leading remaining cause of water quality problems. The effects of nonpoint source pollutants on specific waters vary and may not always be fully assessed (EPA, 2012).

2.3 RIVER CLASSIFICATION

In Malaysia, the Department of Environment was developed the standard to analyze the water quality status of the river which is National Water Quality Standard. Classifying of the water quality status is used Water Quality Index (DOE-WQI) to classify the class of the river and to classify the water it use six parameters which are dissolved oxygen, biochemical oxygen demand, chemical oxygen demand , ammonia nitrogen, total suspended solids and pH. The data obtained from all the six parameters will determine the class of the river which it shows the level of river pollution. Both of standard National Water Quality Standard and Water Quality Index use the class I, II, III, IV and V to categorize and classified the water quality status. Normally, for the class I it shows the river is excellent in water quality and for class V it shows the river poor in water quality. The river standard based on NWQS is shown and the classification of river based on DOE- WQI shows in the Appendix A.

2.4 WATER QUALITY PARAMETERS

Having good water quality is important for a healthy river and ecosystem. Several basic conditions must be met for aquatic life to thrive in the water. Thus, various water quality parameters need to be measured in order to determine the health of the river water so that it is safe to use for any purpose (DOE, 2011). In order to develop a water quality or river index, there are several parameters that need to be considered. These parameters can be divided into three groups, which are physical, chemical and biological.

2.4.1 Physical Parameters

There are many types of physical parameters such as temperature, turbidity, total dissolved solids, total suspended solids, which used for the evaluation of water quality (DOE, 2011). Each of the parameters has significant impact on the water quality. The water temperature is a measure of the heat content of the water mass and influences the growth rate and survivability of aquatic life.

2.4.1.1 Temperature

Temperature can exert greater control over aquatic communities. If the overall water body temperature of a system is altered, an aquatic community shift can be expected. In water above 30 $^{\circ}$C, a suppression of all benthic organisms can be expected. Many of the physical, biological, and chemical characteristics of a river are directly affected by temperature. Most waterborne animal and plant life survives within a certain range of water temperatures, and few of them can tolerate extreme changes in temperature (WSDE, 2002).

Temperature can affect the water quality parameters. The concentration of Chemical and Biological Oxygen Demand are relatively relate to the temperature, by increasing the temperature the concentration for both parameters will be increased. Besides, the increase of heat in the water can reduce the ability of dissolved oxygen and affect the aquatic species in the water. When dissolved oxygen drop below 4 to 5 mg/L, most of the fish will kill and if dissolved oxygen is completely removed all fish and other aquatic life are driven out and killed.

2.4.1.2 Turbidity

Turbidity indicates the amount of fine particles suspended in water. High concentrations of particles can damage the habitats for fish and other aquatic organisms (Said et al., 2004). Turbidity is more concern with aesthetic point of view. High turbidity water shortens the filter runs. Many pathogenic organisms may be encased in the particles and protected from the disinfectant (Avvannavar and Shrihari, 2007). Turbidity may be due to organic or inorganic constituents. Organic particulates may harbour microorganisms. Thus, turbidity conditions may increase the possibility of waterborne disease. Nonetheless, inorganic constituents have no notable health effects.

2.4.1.3 Total Suspended Solids

Total suspended solids (TSS) are an indication of the amount of erosion that took place nearby or upstream. This parameter would be the most significant measurement as it would depict the effective and compliance of control measures e.g. riparian reserve along the waterways. The series of sediment changes that can occur in a water body may change the composition of an aquatic community. First, a large volume of suspended sediment will reduce light penetration, thereby suppressing photosynthetic activity and algae. This leads to fewer photosynthetic organisms available to serve as food sources for many invertebrates. As a result, overall invertebrate numbers may also decline, which may then lead to decreased fish populations. Sediment deposition may also affect the physical characteristics of the stream bed. Sediment, which is generally negatively charged, attracts positively charged molecules. Some of these molecules phosphorus, heavy metals, and pesticides are pollutants. These positively charged pollutants are in equilibrium with the water column and are often released slowly into the water resource

2.4.2 Chemical Parameter

Chemical parameters will be contribute with pH, dissolved oxygen , biochemical oxygen demand , chemical oxygen demand , ammonia nitrogen, total nitrogen and heavy metal are used to determine the water quality.

2.4.2.1 pH

The parameter of pH is a measure the degree of acidity or alkalinity relative to the ionization of water sample. By definition, the pH scale is the concentration of the hydrogen ion. Most pH readings range from 0 to 14. Water with pH less than 7 are acidic, while water with pH greater than 7 alkaline. Most natural waters will have pH values from pH 5.0 to pH 8.5; the acidic, freshly fallen rain water may have a pH value of 5.5 to 6.0. If it reacts with soils and minerals containing weak alkaline materials, the hydrogen ion concentration will decrease. The water may become slightly alkaline with a pH of 8.0-8.5. Water is more acid in the range 5.0 and more alkaline in the range 8.5 to 9.0 so it should be viewed with suspicion. Sudden changes in pH values serve as warning signals that water quality may be adversely affected through the introduction of contaminate.

2.4.2.2 Dissolved Oxygen

The dissolved oxygen concentration depends on the physical, chemical and biochemical activities in the water body, and its measurement provides a good indication of water quality. It can range from 0-18 parts per million (ppm), but most natural water systems require 5-6 parts per million to support a diverse population. When organic matter such as animal waste or improperly treated wastewater enters a body of water, algae growth increases and the dissolved oxygen levels decrease as the plant material dies off and is decomposed through the action of the aerobic bacteria. Changes in dissolved oxygen concentrations can be an early indication of changing conditions in the water body.

The concentration of dissolved oxygen relates to the temperature reading. The aquatic species can be live in the water with the DO above 5 mg/L but when in it drop below 5 mg/L, the aquatic life will be hard to survive because the concentration of oxygen was low and difficult for them to live in the water.

2.4.2.3 Biochemical Oxygen Demand

Biochemical oxygen demand (BOD) is usually defined as the quantity of oxygen utilized by a mixed population of microorganisms to biologically degrade the organic matter in the wastewater under aerobic condition. The term of decomposable may be interpreted as meaning that the organic matter can serve as food for the bacteria and energy is derived from its oxidation. This is very important parameter in water pollution control. It is used as a measure of organic pollution as a basis for estimating the oxygen needed for biological processes and as an indicator of process performance. The BOD test provides a rough idea of how much biodegradable waste is present in the water (WSDE, 2002).

2.4.2.4 Chemical Oxygen Demand

Chemical oxygen demand (COD) is a measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. It is a measurement of the oxygen equivalent of the materials present in the wastewater that are subject to oxidation by a strong chemical oxidant. When wastewater contains only readily available organic bacterial food and no toxic matter, the COD test results provide a good estimate of BOD (Biochemical Oxygen Demand) values. Chemical oxygen demand (COD) test is commonly used to measure the amount of organic and inorganic oxydizable compounds in water. Most applications of COD determine the amount of total oxidizable pollutants found in surface water, making COD a useful measure of water quality. It is expressed in milligrams per litre (mg/L), which indicates the mass of oxygen consumed per litre of the solution.

2.4.2.5 Ammonia Nitrogen

Ammonia nitrogen (NH_3-N) is an inorganic dissolved form of nitrogen that can be found in water and is the preferred form of algae and plant growth. Ammonia is the most reduced form of nitrogen and is found in water where dissolved oxygen is lacking. When dissolved oxygen is readily available, bacteria quickly oxidize ammonia to nitrate through a process known as nitrification. Other types of bacteria produce ammonia as they decompose dead plant and animal matter. It will depend on temperature and pH (a measurement of acidity), high levels of ammonia can be toxic to aquatic life.

High pH and warmer temperatures increase the toxicity of a given ammonia concentration. High ammonia concentrations can stimulate excessive aquatic production and indicate pollution. So, ammonia nitrogen is a measure for the amount of ammonia, a toxic pollutant often found in landfill leach ate and in waste products, such as sewage, liquid manure and other liquid organic waste products. It can also be used as a measure of the health of water in natural bodies such as rivers or lakes, or in man-made water reservoirs. The term is used widely in waste treatment and water purification systems.

2.4.2.6 Selected Heavy Metal Test

Heavy metal testing is a part of chemical parameter in term of to classify the water quality. Metals occur naturally and become integrated into aquatic organisms through food and water. Trace metals such as copper, selenium, and zinc are essential metabolic components at low concentrations. However, metals tend to bio accumulate in tissues and prolonged exposure or exposure at higher concentrations can lead to illness. Elevated concentrations of trace metals can have negative consequences for both wildlife and humans. Human activities such as mining and heavy industry can result in higher concentrations than those that would be found naturally (Carr and Neary, 2006).

The heavy metals normally occurring in nature are not harmful to our environment because they are only present in very small amounts (Sanayei et al., 2009). However, if the levels of these metals are higher than the recommended limits, their roles change to a negative dimension. Human beings can be exposed to heavy metal through direct and indirect sources such as from food, drinking water, exposure to industrial activities. Drinking water is one of the important sources of heavy metals for humans. Concentration of the heavy metal ions in drinking water is generally at mg/L.

Through this project is to determine the concentration of heavy metals of ferum, cadmium, zinc, manganase and lead by using Atomic Absorption Spectrophotometer. A selection of heavy metals is related to the land use at the sample station where, there have industrial area, commercial area and also residential area. Knowing that, ferum is occurring at industrial area which is from the corrosion materials and also can be from natural deposits. Usually it colourless and when it's exposed to air the water turn to cloudy and when too much exposed with since it can affect the human body system.

Meanwhile cadmium occurs mostly in associations with zinc and gets into the water from corrosion of zinc coated pipes and fitting (Gebrekidan et al., 2011). The higher concentration of heavy metals known have a toxic potential. Usually, the main sources of cadmium are from industrial activities and the small quantities of cadmium cause adverse change in the arteries of human kidney. Zinc occurs from the industrial area also and the presence is related to cadmium. The high concentration of zinc can be toxic to the organism (Gebrekidan et al., 2011). Manganese and lead are most significant of heavy metals because it is toxic and can be harmful to human health. Both of ions are occurring together with ferum, where lead usually through in corrosion of plumbing materials. The high concentration of lead in the body can cause death or permanent damage to the human body system (Hanaa et al., 2000).

2.4.3 Biological Parameter

Biological parameter should also be considered to identify the water quality status of the river. The tests will contribute in this parameter are total coliform and E-coli. Biological test is to detect the level of pollutions caused by living thing especially human, where live or work in the area especially upstream of the site. These tests are based on coliform bacteria as the indicator organism. The presence of these indicative organisms is evidence that the water has been polluted with faeces of humans or other warm-blooded animals.

2.4.3.1 Total Coliform

The total coliform test is the starting point for determining the biological quality of drinking water. This test is performed frequently because of the acute risk that disease causing organisms pose to the users of that water supply. The test is easy to perform and inexpensive (EFS, 2010). The total coliform is considered an indicator, since the presence of bacteria in this group indicates the possibility, but not the certainty, that disease organisms may also be present in the water. When total coliforms are absent there is a very low probability of disease organisms being present in the water.

The types of coliform group can be presented in the total coliform is Fecal Coliforms, Soil Coliforms and others which, can be present in water even when the total coliform test shows an absence of organisms. Under such circumstances illness could occur. Nevertheless, the total coliform test remains the most commonly used standard for determining the bacterial quality of drinking water in the US and the world (EFS, 2010).

2.4.3.2 Escherichia Coli

This is a species within the fecal coliform group. E- coli generate only in the intestines of animals including humans. As with other fecal coliform, they have a relatively short life span compared to non fecal coliform bacteria. Their presence indicates a strong likelihood that human or animal wastes are entering the water system. Immediate public notice and a boil order (within 24 hours) are required due to a higher likelihood of disease organisms also being present in the water (EFS, 2010).

2.4.3.3 Fecal Coliform

Fecal coliform is a group of microorganism which is examples of biological parameters. Fecal coliform is a form of bacteria found in human and animal waste. Fecal coliform are bacteria whose presence indicates that the water may have been contaminated with human or animal fecal material. If fecal coliform counts are high in a site, it is very likely that pathogenic organisms are also present, and this site is not recommended for swimming and other contact recreation (Said et al., 2004). A few microorganisms are an important cause of the corrosion of steel pipes. Water for the purpose of drinking that contained microorganisms can cause sensory defects in odor, color and taste. Various health related problems due to contaminated waters are diarrhea, abdominal cramps and vomiting due to salmonella, cholera is due to Vibro cholera, infection of the lungs due to Mycobacterium (Avvannavar and Shrihari, 2007).

2.5 EFFECT OF RIVER POLLUTION

The river pollution is one bigger problem occur in our country. Even though the government was planned so many ways to attract the public to save our river but it's slightly not successful enough. On 2005, The One State, One River (1S1R) Program was launched in and is aimed in helping the State of Department of Irrigation and Drainage (DID) to organize a river restoration and water quality improvement program for one river in their state, with full stakeholder participation. There are so many effects can be found in river pollution, it can affect the human health. The public will exposed to mankind of disease such as blue baby syndrome, excessive concentration which affects the colour on the teeth and problem in bone growth, the high level of toxic in water can bring cancer, abortion and deformation in a new baby born. The main caused all of the diseases because of the impact of human activities, unsystematic management of rubbish, the discharge of untreated chemical waste into the river will provide the toxins in the water

Besides, the river pollution also can affect our economy development. Usually, the river can be one of the venues for the tourist and in Malaysia there are so many rivers that can attract the tourist. The problem of river pollution it can disturb our tourism industry hence it will affect our economy. It also will decrease the image of Malaysia because by increasing the river pollution it will prove that the government is not caring about the environment. So, the public should be realized with this problem and all this is because of the benefit of our next generation.

2.6 CONCLUSION

The river pollution was increased every year and government need to bear this problem. The public was not realizing that so many cost needs to overcome this problem, they are still doesn't care about the sustainability of the environment. By through the impact of river pollution the public will wake up to protect the cleanest of the river. National Water Quality Standard used by the Department of Environment to identify the standard of water quality status of the river. Meanwhile, to identify the water quality DOE introduced the Water Quality Index (DOE-WQI) to classify the water quality status of the river. The six parameters will be used in term of identifying the water quality which the parameters dissolve oxygen , biochemical oxygen demand, chemical oxygen demand, ammonia nitrogen, total suspended solids and pH. After that, the status of river can be classified based on the classification of WQI.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

The research will be covering the Galing River at Kuantan, Pahang. This research will be determined the water quality status of Galing River based on the water quality parameter. The total of the river basin is 22.65 km^2 and the length of the river is 7.7km, there is a tributary to this river which is Small Galing River which located at Tanjung Api. The sample will be taken at five stations which are contributed with three samples per station. The duration of this research is starting on the second week in September until the fourth week in November. The sample will be taken twice per month which is during the second week and fourth week. The test will be conducted during this research will be covered in situ test and laboratory test, for in situ test it involved with dissolved oxygen, pH, temperature and turbidity. Meanwhile for laboratory test it will cover biochemical oxygen demand, chemical oxygen demand, ammonia nitrogen, total suspended solids, E-coli, total coliform and heavy metal test use Atomic absorption spectrophotometer (AAS). The data obtained from the test will be used to classify the water quality status based on Water Quality Index (DOE-WQI). The Figure 3.1 shows the flow chart methodology of this research.

3.2 THE RESEARCH METHODOLOGY FLOW CHART

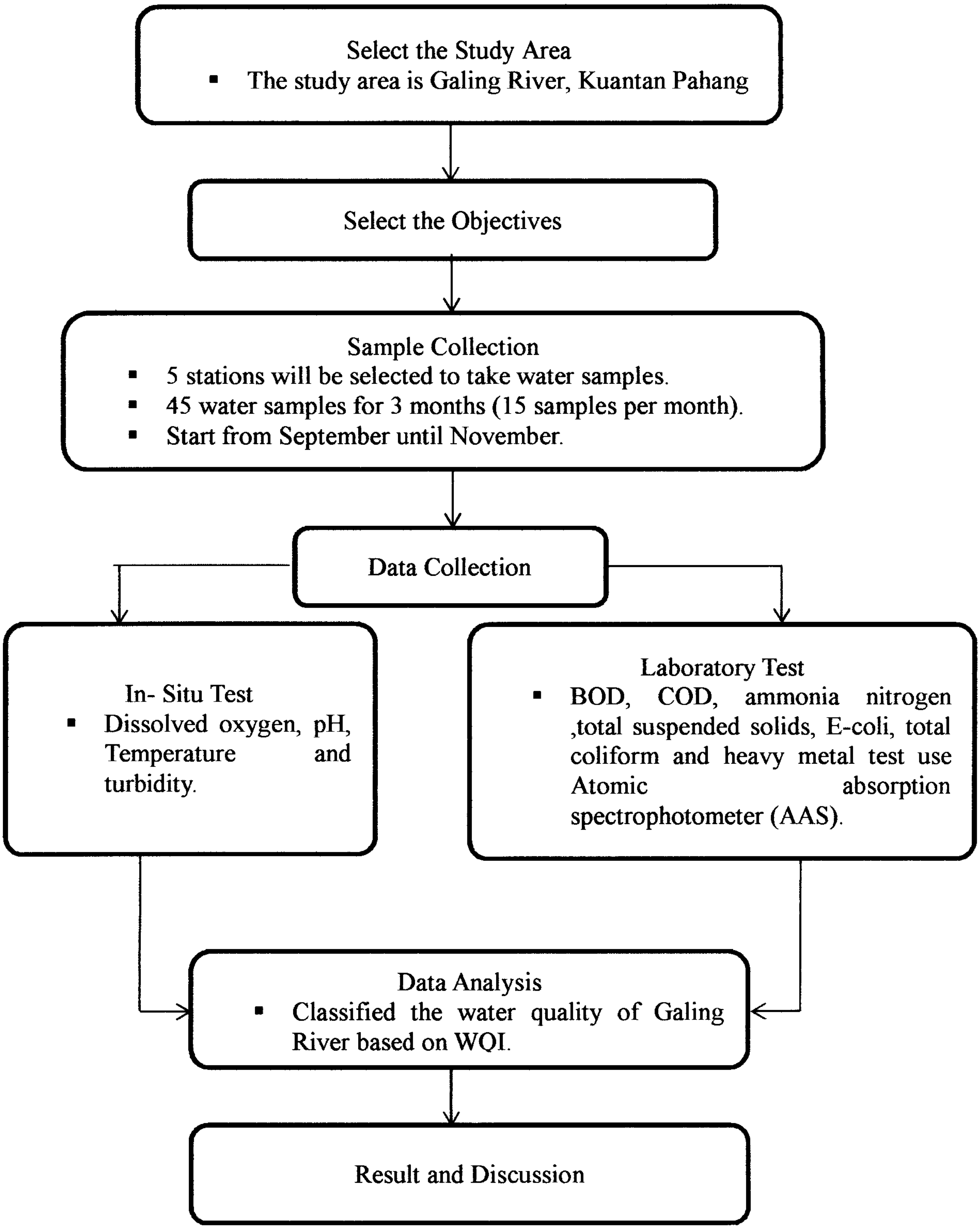

Figure 3.1: Flow chart of the methodology

3.3 STUDY AREA

The study area for this research is at Galing River, Kuantan Pahang, and the total of river basin for this river is 22.65 km^2 for the Big Galing River and for the Small Galing River is 1.1 km^2 . The Figure 3.1 shows the map of Galing River and the stations that will involve for water sampling. The Galing River is along of the Kuantan City which is covered from Semambu area at the upstream of river until Tanjung Api as the downstream of the river. From Table 3.1 it shows the list of sampling stations that contribute in this research.

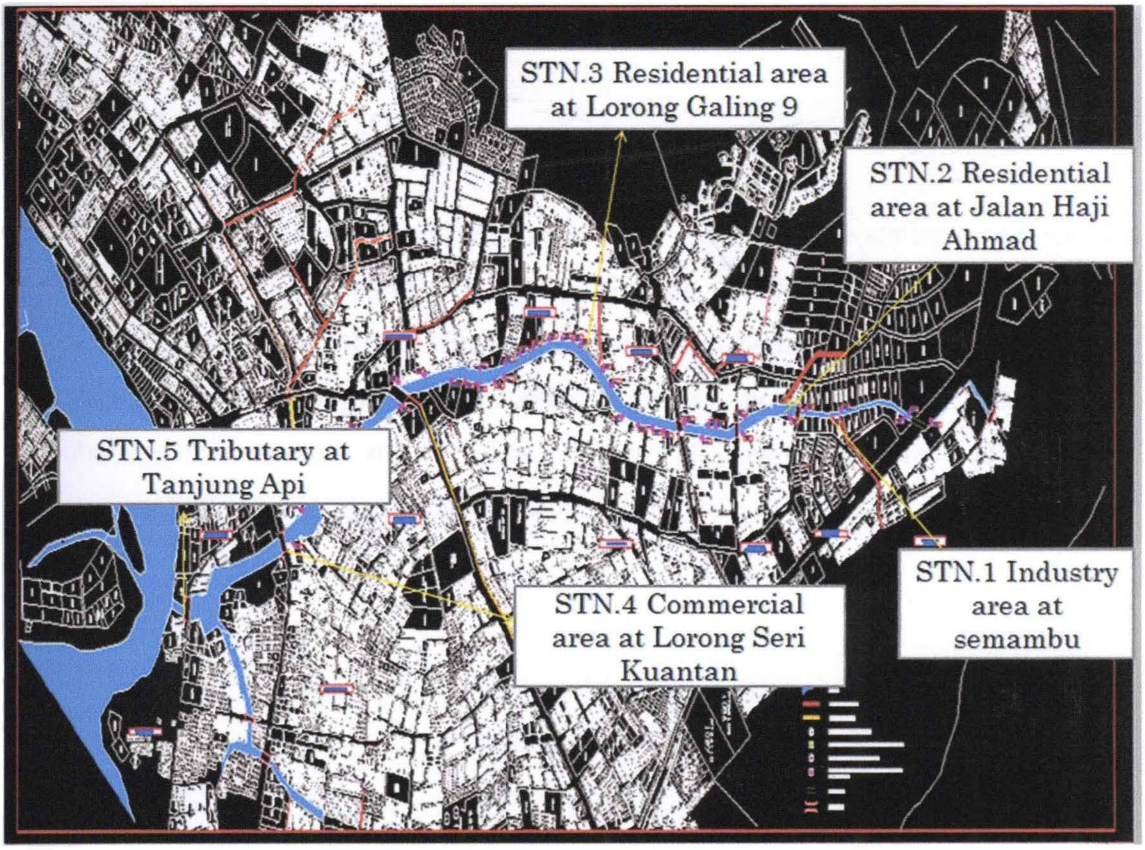

Figure 3.2: Sampling location and study area of Galing River

Table 3.1: Coordinate of sampling stations

STATIONS	LOCATION	COORDINATE
1	Industry area at Semambu	N 03°50.846' E 103°20.091'
2	Residential area at Jalan Haji Ahmad	N 03°50.652' E 103°20.051'
3	Residential area at Lorong Galing 9	N 03°49.420' E 103°20.010'
4	Commercial area at Lorong Seri Kuantan	N 03°49.400' E 103°20.366'
5	Tributary at Perkampungan Tanjung Api	N 03°48.587' E 103°20.908'

3.4 DATA COLLECTION

The sample of water will be taken from the different stations and for this research it will contribute with five stations which are 4 stations at Big Galing River and 1 station at Small Galing River. The water sample will be taken starting on September until November and sample will be taken twice per month. Total of water sample contribute in this research are 45 water samples. The sampling method is follow the standard method of taking sampling water.

3.5 THE APPROACH OF STUDY

In this study it contributes with the in-situ test and laboratory test. Where, for the in-situ test it directly done on site meanwhile for the laboratory test it will be done at laboratory by follow the correct instructions.

3.5.1 In-situ test

The tests involve in in-situ test are pH, temperature, turbidity and dissolved oxygen and the testing by using Horiba Multi Parameter Water Quality. The detector rode is placed in the river water and the value will appear.

3.5.2 Laboratory test

The tests that involve in laboratory test are total suspended solid, biological oxygen demand, chemical oxygen demand, ammonia nitrogen, heavy metal test, total coliform and E-coli. For biochemical oxygen demand, total coliform and E-coli the test must be done in the same day of sampling, for other tests it can be done other day but the water sample must be preserve first.

3.5.2.1 Total suspended solids

Total suspended solids include all the particles suspended in the water which not pass through a filter. As the levels of total suspended solid increase, a water body begins to lose it ability to support a diversity of aquatic life. Suspended solids absorb heat from sunlight, which increase water temperature and subsequently decreases the level of dissolved oxygen. To measure it, the water sample is filtered through a standard glass fibre filter. The residue retained on the filter is dried in an oven at 103 °C to 105 °C until the weight of the filter no changes. The increase in weight of the filter represents the total suspended solids. The calculation of TSS shows in below:

Calculation of Total suspended solids = (A- B) X 100 / C

Where:

A = weight of filter and dish + residue in mg

B = weight of filter and dish in mg

C = volume of sample filtered in mL

3.5.2.2 Biochemical oxygen demand

Biochemical oxygen demand is to measure the amount of oxygen required by the bacteria while stabilising decomposable organic matter under aerobic conditions. This is very important parameter in water pollution control. It is used as a measure of organic pollution as a basis for estimating the oxygen needed for biological processes and as an indicator of process performance. For the BOD test all the procedures are follow the standard set by the Environmental laboratory of Universiti Malaysia Pahang.

Before the test can be start the dilution water need to be prepared first by mix distilled water and BOD pillow. The materials and instruments use during the process shown in the Appendix B. The samples of BOD require dilution water because only oxygen available to the organisms is dissolved in the water. The most oxygen that can be dissolve is about 9 mg/L, so the diluted sample should be between 2-6 mg/L. For a valid BOD test, the final DO should not be less than 1 mg/L and the result of BOD is invalid if DO value near zero. The calculation of BOD value was express in the equation below:

Calculation of BOD_t = $DO_i - Do_t/P$, where:

BOD = biochemical oxygen demand, mg/L

DOi = initial DO of the diluted sample about 15min after preparation, mg/L

Do_t = final DO of the diluted sample after incubation for t days, mg/L

P = Dilution factor = Volume sample / (volume sample + volume dilution water)

3.5.2.3 Chemical oxygen demand

Chemical oxygen demand is used to measure of the capacity of water to consume oxygen during the decomposition of organic matter and the oxidation of inorganic chemicals such as ammonia and nitrite. It is a measurement of the oxygen equivalent of the materials present in the wastewater that are subject to oxidation by a strong chemical oxidant. When wastewater contains only readily available organic bacterial food and no toxic matter, the COD test results provide a good estimate of BOD values.

The procedure of COD test also follows the standard procedure setup by Environmental Laboratory of Universiti Malaysia Pahang and the materials and instruments that use during the test shown in the Appendix B. For this research the type of vial use is low range which the COD value supposed in the range of 3-150 mg/L but if the results exceed the range the sample need to dilute by using distilled water before pipet the sample into the vial. The purpose of dilute is to reduce the chloride concentration and the ration of dilution is depending on the value that exceed during the test. HACH DR 5000 program used to measure the value of COD and the selection of program is depend on the type of COD vial that will be use.

3.5.2.4 Ammonia nitrogen

Ammonia nitrogen is an inorganic dissolved form of nitrogen that can be found in water and is the preferred form for algae and plant growth. Ammonia is the most reduced form of nitrogen and is found in water where dissolved oxygen is lacking. When dissolved oxygen is readily available, bacteria quickly oxidize ammonia to nitrate through a process known as nitrification. Ammonia nitrogen measured in mg/L and the laboratory procedures follow the standard practice of the Environmental Laboratory of Universiti Malaysia Pahang.

The value of ammonia nitrogen depends on temperature and pH, high levels of ammonia can be toxic to aquatic life. High pH and warmer temperatures increase the toxicity of a given ammonia concentration. High ammonia concentrations can stimulate excessive aquatic production and indicate pollution. Important sources of ammonia to lakes and streams can include fertilizers, human and animal wastes, and by products from industrial manufacturing processes. Techniques to prevent high ammonia concentrations involve filtration of runoff water especially from barnyards and other areas where animals may be kept in larger numbers, proper septic system maintenance, and not over-fertilizing yards or fields.

3.5.2.5 Selected heavy metals test

In this study it required to do heavy metal test and the selected of heavy metals are ferum, cadmium, manganese, zinc and lead. By using Atomic Absorption Spectrophotometer (AAS) the concentration value of heavy metals can be determine and all the procedures was guide by the technician at the Environmental Laboratory. Flame was used to determine the value of concentration, by heating the flame for selected heavy metals AAS will read the concentration by three times and the final value is from the mean of concentration value.

But, before the test can be start, the standard for heavy metal must be preparing first the value of ppm for heavy metal is depending on the researcher. The calculation of volume standard is show in below:

$$m1v1 = m2v2$$

$$1000ppm\ (x) = 1ppm\ (250)$$

$$x = 0.25 \text{ (to convert in microgram/L must X 1000)}$$

$$x = 250\mu g/L$$

3.5.2.6 Total coliform and Escheriachia coli

Total coliform is used as indicator organisms which it consider not caused the diseases for human and animals but the presence of total coliform usually indicates with presence of pathogenic. Meanwhile for E-coli it produces the positive of total coliform respond. The procedure of total coliform and E-coli tests are follow the standard method practice and the method use is Quanti-Tray and Quanti-Tray 2000 (SM 9223 B) approved by EPA and the type of enzyme use is Colilert to detect either presence or absence organisms.

The test must be done in the same day of sampling, it cannot be delayed because it will disturb the result and all the procedures must be following. The safety equipment such as mask, plastic glove must wear during the test as a precaution. For reading the tray there is a method that must be following, where to count the number of well for total coliform count for both small and large yellow wells and use colour comparator to confirm positive result. Meanwhile for E-coli use the UV lamp to check for fluorescence if no wells fluoresce it show negative for E. coli but if wells do fluoresce, it has positive for E. coli. For the value of E-coli it can be refer to table for MPN and the table show in the Appendix B.

3.6 DATA ANALYSIS

The data will be analysis by doing the test which is covered in-situ test and laboratory test. During the sampling of water the in-situ test will be done at site, where it involved pH, dissolved oxygen, temperature and turbidity. After that, the water sample will be preserved for laboratory test and not all the test need to preserve the water sample, it's only for chemical oxygen demand test and heavy metal test. Some of the laboratory tests need to do in same day such as ammonia nitrogen, total coliform and E-coli. The different of water sample bottle will be used, for example for biochemical oxygen demand it required dark bottle for water sampling meanwhile for other test it just required plastic bottle to keep the water sample. The data establish from the test will be used for classifying the water quality status based on Water Quality Index practiced by the Department of Environment.

The WQI approved by the DOE is calculated based on the six parameters. Among them DO carries maximum weightage of 0.22 and pH carries the minimum of 0.12 in the WQI equation. The WQI equation eventually consists of the sub-indexes, and the formula of sub-indexes can refer in Appendix A. The WQI equation calculated according to the best-fit relations given in equation below. The formulas used in the calculation of WQI are:

$$WQI = 0.22\ SIDO + 0.19\ SIBOD + 0.16\ SICOD + 0.16\ SITSS + 0.15\ SIAN + 0.12\ SIpH$$

3.7 CONCLUSION

The data obtained through the measurement at in situ test and laboratory test and it was analyzed by using Microsoft Excel. From the result it will be used to determine the water quality status of Galing River based on NWQS and DOE-WQI. The data establish from the research will be useful and helpful for the government to do policy making. The research also will be conduct at two types of Galing River because there is a tributary which is Big Galing River at Semambu area and Small Galing River at Tanjung Api, Kuantan Pahang. All the result of data analysis shown and discuss in detail in Chapter 4.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

All the results finding from the in situ test and laboratory test will be analyzed and discuss in this chapter. Through the process of test to determine the water quality status of the Galing River by using three types parameters which are physical, chemical and biological. The tests involved in physical parameter are temperature, turbidity and total suspended solid. Meanwhile for the chemical parameter it includes pH, dissolved oxygen, biological oxygen demand, chemical oxygen demand, ammonia nitrogen, selected heavy metal test. For biological parameters are total coliform and Escherichia coli. The results from all the test was analyzed by using Microsoft Excel to transfer into the bar chart.

4.2 ANALYSIS OF RESULT

Department of Environment set the standard of water quality for each parameter of water which is National Water Quality Standard and DOE- WQI. All the result from in situ test and laboratory test will be analysis by using both of standards to determine the water quality status of Galing River. Each parameter must meet the standard of every water class. According to the formula in DOE-WQI the status of Galing River can be recognized by using the class which the Class I show the clean river meanwhile Class V shows polluted river.

4.3 PHYSICAL PARAMETER

4.3.1 Temperature

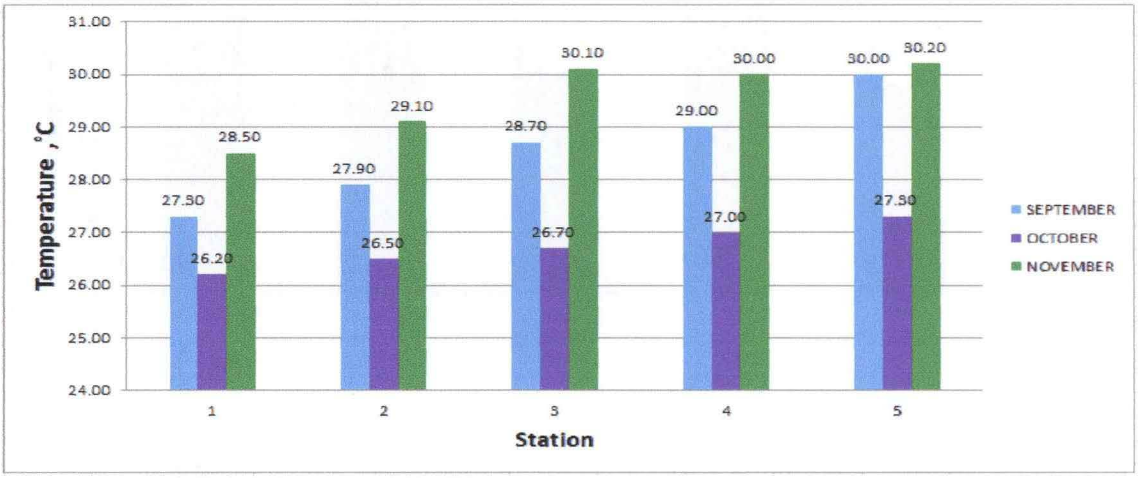

Figure 4.1: Comparison of temperature value (°C) at different stations

According to the Figure 4.1, the bar chart shows the average of temperature for different station for different month. The ranged of temperature between 26.30 – 30.20 °C where the lowest temperature at Station 1 meanwhile the highest temperature was at Station 5 with the temperature 30.20 °C. The different reading of temperature affect by the land use and the time during the sampling.

4.3.2 Turbidity

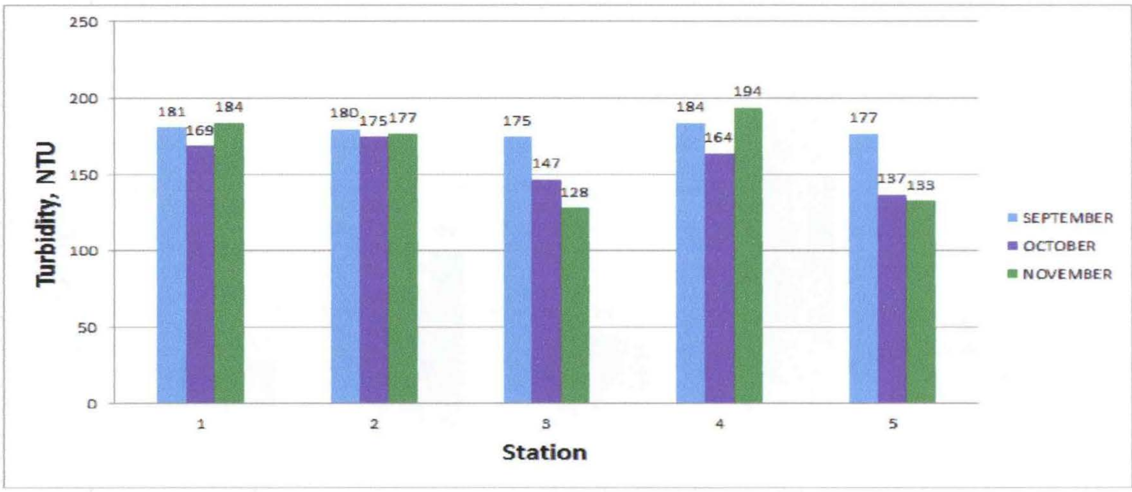

Figure 4.2: Comparison of turbidity value at different stations

According to the Figure 4.2, the maximum average value of turbidity was at Station 4 which the highest value was 194 NTU. Meanwhile, the lowest value was at Station 3 with the value 128 NTU. The highest of turbidity valued was located in a commercial area where there were lots of activities being there such as shopping malls, hotel, restaurant and workshop. Most of waste water was directly discharged into the river without proper treatment process. The increased waste water level in the river it lead the high concentration of turbidity. According to the value of turbidity for the Galing River it was in Class IIB based on National River Water Quality Standard for Malaysia. Turbidity was used to measure the cloudiness of water and high turbidity may indicate the presence of disease caused by the organisms include bacteria, viruses and parasites.

4.3.3 Total Suspended Solids

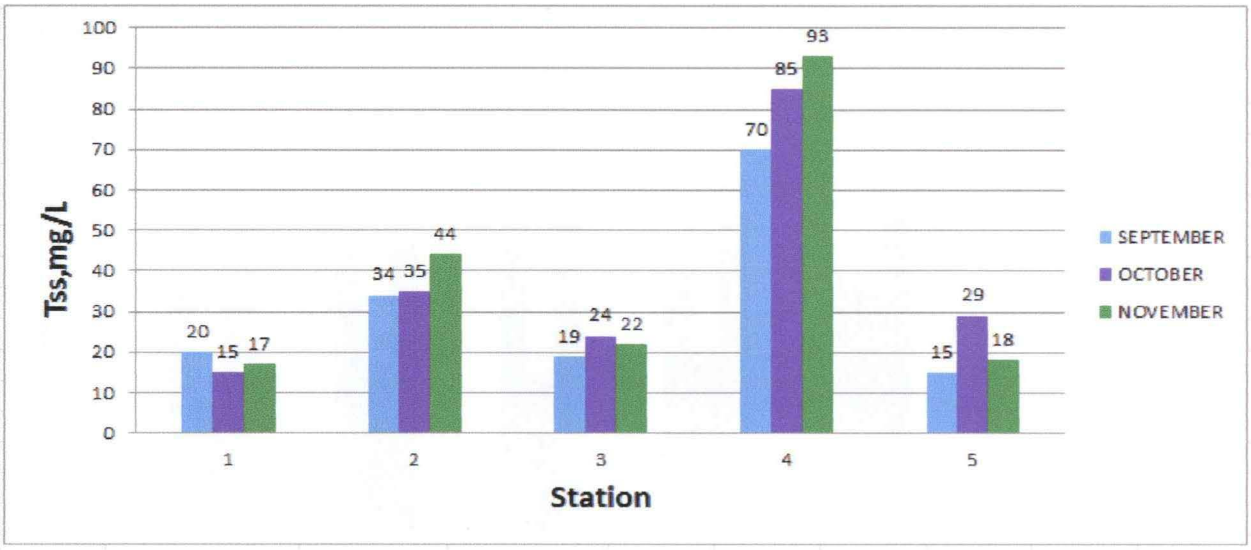

Figure 4.3: Comparison of total suspended solids value at different stations

According to the bar chart, total suspended solids were found in the range of 15 – 93 mg/L, which at Station 4 was classified the highest value of total suspended solid which meanwhile the lowest value was at Station 1. The high value of total suspended solids was affected by the land use of the sampling station. Due to the Station 4 it was commercial area, where there were lots of activities being there and leads to the increased value of turbidity and directly increased value of total suspended solids. According to the WQI scale, Galing River was in Class III.

4.4 CHEMICAL PARAMETER

4.4.1 pH

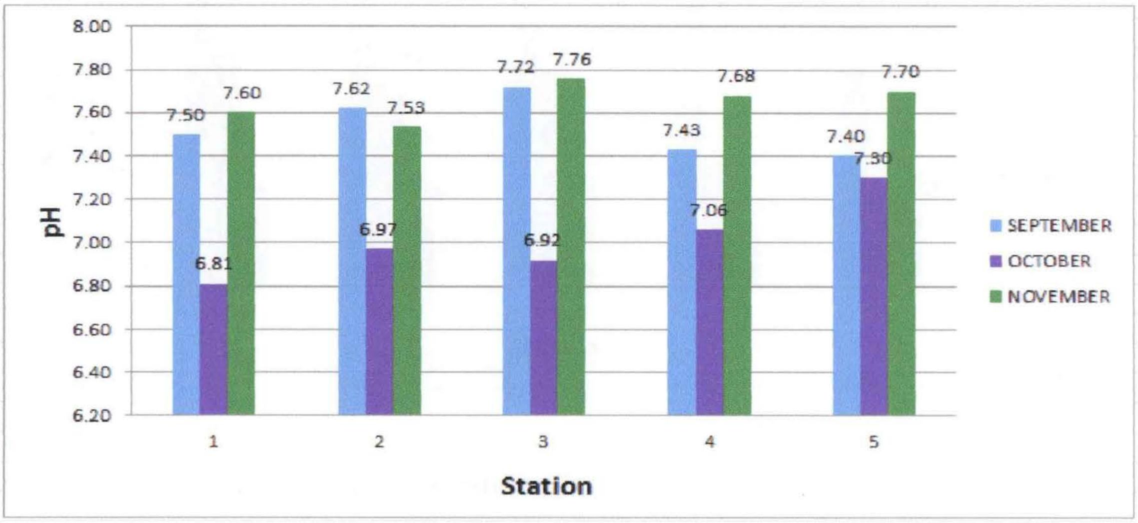

Figure 4.4: Comparison of pH value at different stations

The pH was an important indicator for the water quality, from the Figure 4.4 the range of pH was between 6.81 – 7.76. Overall the pH value for every station was found alkaline for both upstream and downstream. Due to Station 3 it was higher pH which 7.76 meanwhile at Station 1 there was the lowest value of pH which caused by the industrial waste. According to the value of pH for the Galing River it was in Class I based on National River Water Quality Standard for Malaysia.

4.4.2 Dissolved oxygen

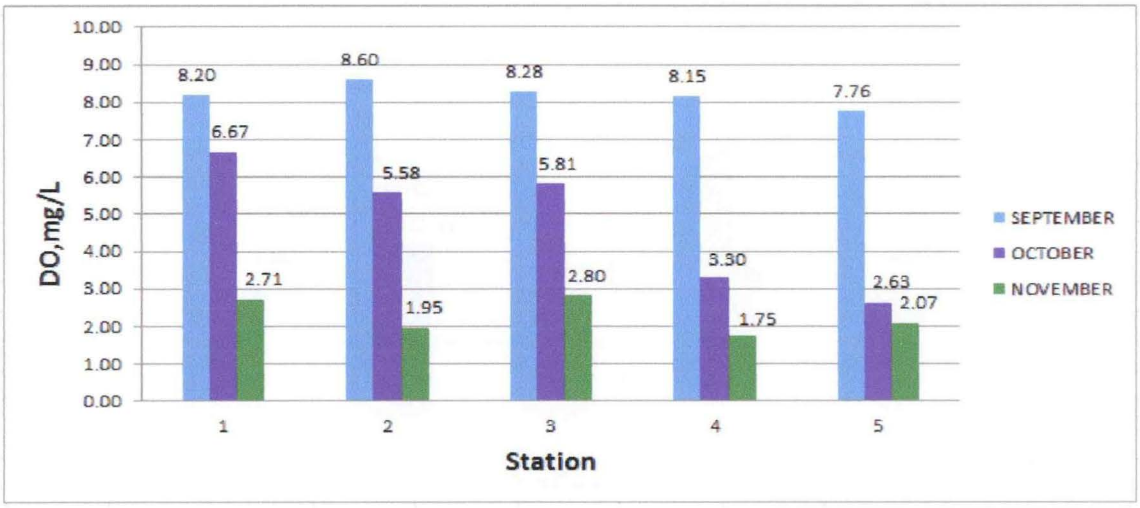

Figure 4.5: Concentration of DO value at different stations

According to the figure, the ranges for the concentration of dissolve oxygen between 1.75 – 8.60 mg/L. At the whole area DO concentrations were found less than the standard limit of DOE-WQI which the limit of DO should 7.0 mg/L. The low concentration was found at Station 4 with the reading 1.75 mg/L. It was due to the discharging of commercial wastes, containing high concentration of organic matter and nutrient and probably due to the microbial activities to degrade the organic matter (Nasly et al., 2013). The dissolve oxygen was influent by the temperature because the increasing of temperature it cannot hold the oxygen in water. According to the value of DO for the Galing River it was in Class II based on National River Water Quality Standard for Malaysia.

4.4.3 Biochemical oxygen demand

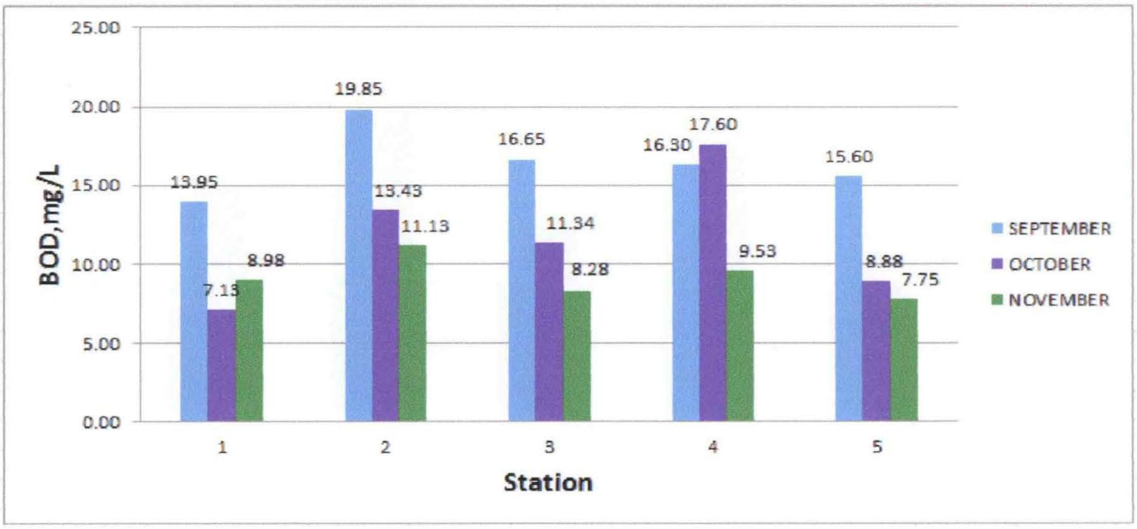

Figure 4.6: Concentration of BOD value at different stations

BOD is a measure of the amount of oxygen removed from aquatic environments by aerobic microorganisms for their metabolic requirements during the breakdown of organic matter, and systems with high BOD tend to have low dissolved oxygen concentrations (Carr et al., 2006). According to the figure, the range of BOD was between 7.13- 19.85 mg/L which it was more than the limit in DOE-WQI. The highest BOD concentration was found in Station 2 which due to the residential waste and industrial waste, and at the lowest at Station 1. The presence of organic matter in the waste water influent the concentration of BOD because bacteria need oxygen to biologically degrade the organic matter in the waste water under aerobic condition. According to the value of BOD for the Galing River it was in Class V based on National River Water Quality Standard for Malaysia.

4.4.4 Chemical oxygen demand

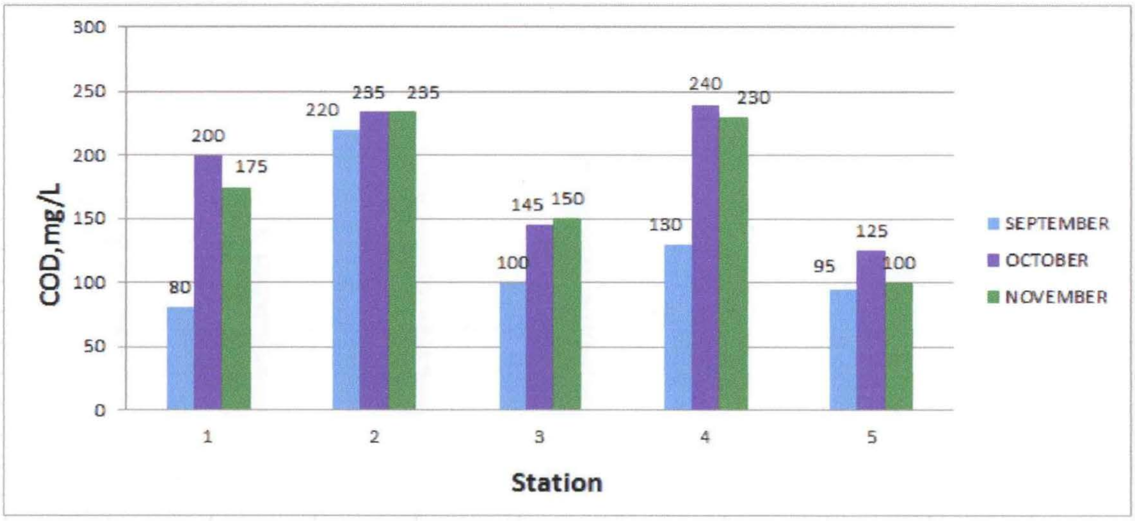

Figure 4.7: Concentration of COD value at different stations

COD test is commonly used to measure the amount of organic and inorganic oxydizable compounds in water. Most applications of COD determine the amount of total oxidizable pollutants found in surface water, making COD a useful measure of water quality (Carr et al., 2006). According to the Figure 4.7, the range concentration of COD was between 80 – 240 mg/L for the Galing River. It revealed that concentration of COD was found higher in all station compare to DOE-WQI where the water should have COD less than 10 mg/L. The highest value of COD was found at Station 2 meanwhile the lowest at Station 5. The concentration of COD positively correlated with BOD value. According to the value of COD for the Galing River it was in Class V based on National River Water Quality Standard for Malaysia.

4.4.5 Ammonia nitrogen

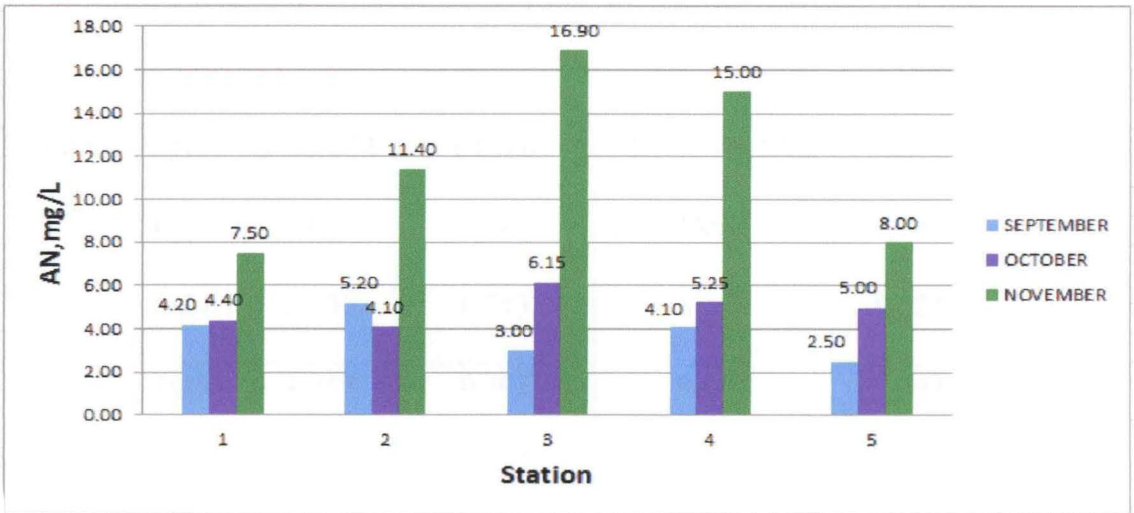

Figure 4.8: Concentration of AN value at different stations

According to the Figure 4.8, the range of ammonia nitrogen concentration for Galing River was between 2.50 – 16.90 mg/L. The value of ammonia nitrogen was exceed the limit DOE- WQI where the water should contain less than 0.1 mg/L of ammonia nitrogen. The high concentration of ammonia nitrogen was due to the residential area and commercial activities. It was because of intense commercial activities at the region and higher pH value, as pH was found positively correlated (Nasly et al., 2013). Based on to the value of ammonia nitrogen for the Galing River it was in Class V based on National River Water Quality Standard for Malaysia.

4.4.6 Selected of heavy metal test

Table 4.1: Concentration of heavy metals value at different stations

STATION	UNIT	FERUM	LEAD	MANGANESE	ZINC	CADMIUM
1	mg/L	2.091	0.681	0.063	0.046	0.036
2	mg/L	3.970	0.713	0.132	0.021	0.026
3	mg/L	1.619	0.702	0.087	0.043	0.035
4	mg/L	0.916	0.723	0.069	0.037	0.039
5	mg/L	1.437	0.738	0.029	0.018	0.035

In this research the concentration of heavy metals: Fe, Cd, ZN, Mn and Pd in the Galing River were analyzed. The selection of heavy metals relate with the land activities at the sampling stations. Highest heavy metal concentration was found for ferum with the concentration 3.970 mg/L. According to the NWQS, level concentration of ferum and cadmium was over the limit in the standard and was classified in Class V.

Ferum was the most heavy metal occurred in the Galing River. In water, it occurs mainly in ferrous or ferric state (Ghulaman et al., 2008). Ferum in the surface water generally presence because industrial waste due to the corrosion materials. According to the Table 4.1, the high concentration of ferum was found at Station 2 due to the discharging waste water from residential and industrial activites. The high concentration of ferum may lead to the disease and danger to the human health and environment. In this study, the value of ferum was exceeding the limit of Malaysia Standard which it must less 1 mg/L in river water. This could be happened improper treatment process of waste water before discharging to the river.

Lead was the second highest concentration of heavy metals in the Galing River. The high concentration was found at Station 5 with the range 0.738 mg/L and it was classified in Class IV according to the NWQS. The presence of lead in water related with the presence of ferum because generally lead occurs in water caused by the lead materials and corrosion material. In the residential area lead presence in the piping material, at the industrial activities in can be inhaled in the dust from lead paints or waste gases from leaded gasoline. High concentration of lead was lead to the danger in the human body system; it can cause death or permanent damage to the central nervous system, the brain and kidneys (Hanaa et al., 2000). Most of samples contain the exceed limit of concentration of lead in the river water due to the limit standard NWQS which it must less 0.05 mg/L.

Manganese was the middle level of concentration heavy metal in Galing River. The high concentration was found at Station 2 due to the meeting point for the residential waste and industrial waste. Usually, manganese occurs together with ion but in lower concentration. According to the NWQS the concentration of manganese was less than the limit. The high concentration of manganese can caused the problem in human health and also to the environment. Zinc is the one important trace element for heavy metal test. According to the Table 4.1, it shows fairly low concentration in surface water due to land use for sampling stations. In this study, the low concentration was found 0.018 mg/L at Station 5 and the high value at Station 1 where due to the tributary of Galing River and industrial area respectively. The high concentration of zinc can be toxic to the organism and according to the NWQS the concentration of zinc was under the range of limit.

Cadmium occurs in low concentration compare with other heavy metals and usually it occurs mostly with Zinc and gets into the water from corrosion of zinc coated pipes and fittings. Due to the lower concentration of zinc it was lead the lower concentration of cadmium. According to the table, the high concentration was found at Station 4 with the value 0.039 mg/L and it was exceed the limit in NWQS, meanwhile the lower concentration 0.026 mg/L at Station 2. Due to the commercial activities it develops high level of waste water and according to the study most of the waste water was improper treated and directly discharge into the river. Cadmium is highly toxic and caused poisoning through food. The small quantities of cadmium cause adverse changes in the arteries of human kidney and not safe to our environment (Gebrekidan et al., 2011).

4.5 BIOLOGICAL PARAMETER

4.5.1 Total coliform

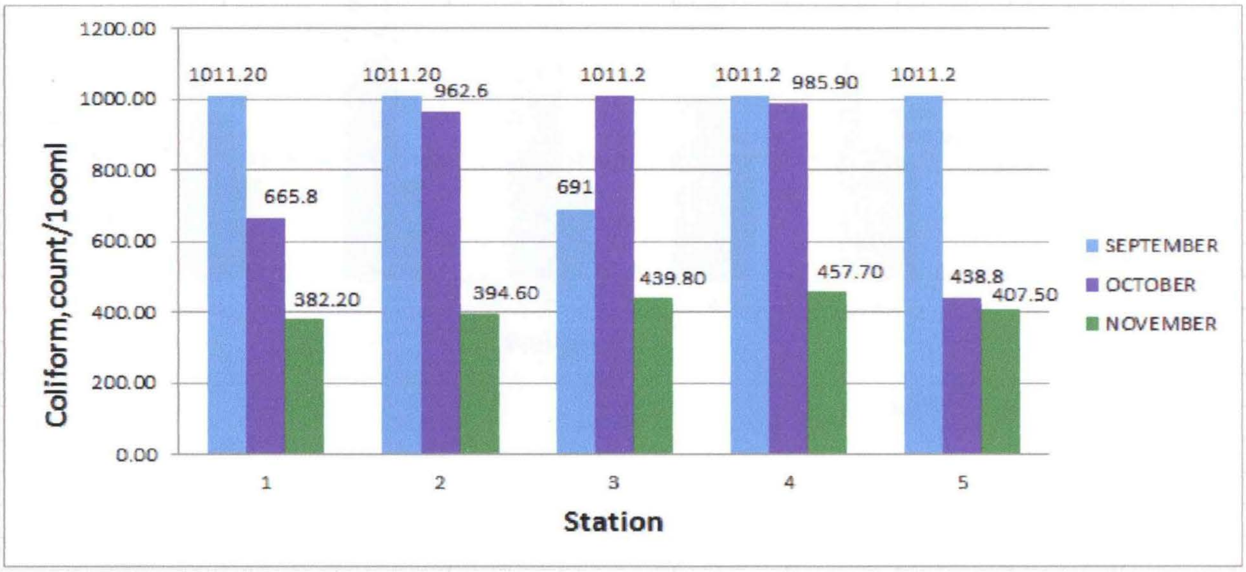

Figure 4.9: Count of total coliform value at different stations

According to the Figure 4.9 show the count of total coliform at different stations and the range of count between 382.20 – 1011.2 count/ 100ml. The highest value was found at Station 4 which 1011.2 count/100ml and the lowest 382.20 count/100ml at Station 1. The highest numbers of total coliform show the presence of pathogenic organisms that can cause diseases. Their presence does not necessarily imply contamination from waste water nor the presence of other sanitation based health risks. The presence of total coliform by itself does not imply an imminent health risk but does indicate the need for an analysis of all water system facilities and their operations to determine how these organisms entered the water system (EFS, 2010).

4.5.2 Escherichia coli

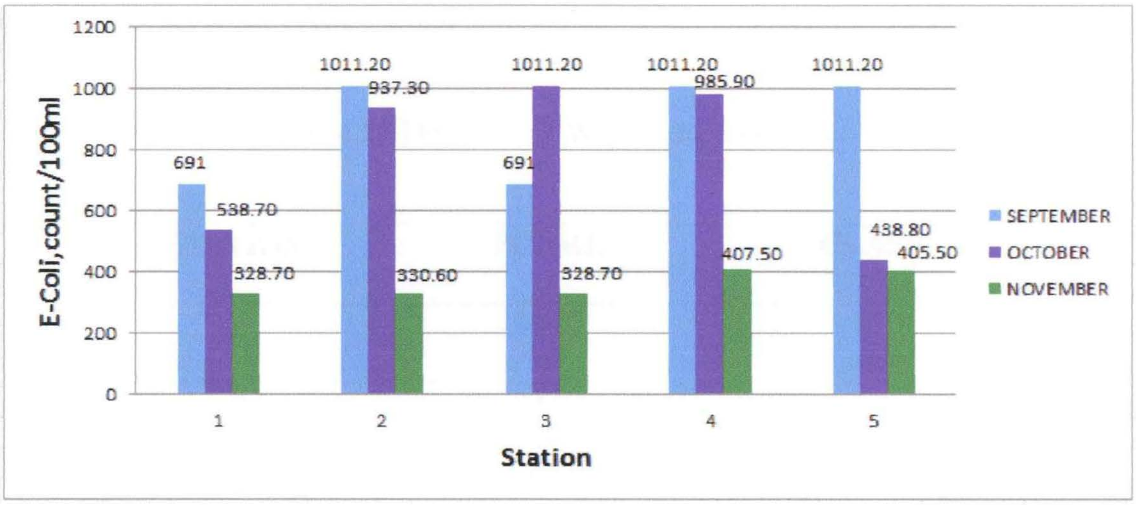

Figure 4.10: Count of E-coli value at different stations

According to the bar chart, the average maximum value of E- coli was 1011.2 count/100ml at four different stations which at Station 2, 3, 4 and 5 and the lowest value 328.70 count/100ml at Station 1. It was clearly shows the high presence of pathogen at Galing River. Generally, E-coli can be not pathogenic and pathogenic which for not pathogenic it show some beneficial. Although generally not pathogenic, their presence indicates a pathway for human pathogens (ex. Viruses, bacteria) to enter the water source (Alloway et al., 2011). E- coli is a species of bacteria within the fecal coliform group and dominant bacteria found in waste of humans and warm-blooded animals. The presence of E- coli it positively correlated with total coliform and it possesses an enzyme called (ß-glucuronidase) which releases fluorogen can be detect by using a 365 nm UV lamp.

4.6 COMPARISON WATER QUALITY INDEX FOR EACH STATION

4.6.1 The WQI for Galing River

Table 4.2: The score of WQI at different stations

STATION	SCORE	CLASS
1	38.67	IV
2	32.98	IV
3	38.24	IV
4	30.14	V
5	39.96	IV

According to the Table 4.2 above, the range score for WQI at different stations was 30.14 – 39.96 for three months. It was found that at Station 4 the station was classified under Class V which was the most polluted, meanwhile other station was under Class IV. Due to the Station 4 it was commercial area and most of the result from the entire test for parameter shows that it has highest value of concentration of turbidity, total suspended solids and lower concentration in dissolve oxygen.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 INTRODUCTION

Galing River is the one of river in Pahang and according to the Department of Irrigation and Drainage the water quality of Galing River was at poor water quality. Due to the land use activities at upstream of river it was influence the quality of water. According in this study, the upstream of river was located at Semambu and most of Galing River is connected with Semambu area. By knowing that, the water quality of Galing River was affected by the industrial area and directly affect the water quality at downstream of river.

The sampling of water was done at different types of station and it was involved with five sampling stations at different area and type land use. All the samples was contribute with the in – situ test by using Horiba instrument and laboratory test and all the results was discuss in Chapter 4. Each of result was compared to the National Water Quality Standard and Water Quality Index to determine the water quality status for every station.

According to the DOE- WQI, the Galing River was classified under Class IV, which the score was calculated 36.00. In this class the river water was in fair water quality and suitable for irrigation activities only. The aquatics life is not suitable to live in this river because the concentration of dissolve oxygen is lower and there is high presence of pathogenic. From the score of WQI, it was found that Station 4 under Class V and classified as most polluted. According to the results of turbidity and total suspended solid at Station 4 have the high value of reading, meanwhile the concentration of dissolved oxygen it have the lower value which 4.40 mg/L. The count of total coliform and E- coli was high compare with other station. It clearly shows the high presence of pathogen and it indicates the presence of disease that can be harmful to the human. According to the heavy metal test it shows the high concentration of cadmium and it can affect the human body system.

In summary, the source of polluted at Galing River was at point source where it still can be reduce by using the proper treatment process for waste water. The point source at Galing River was classified from industrial area, commercial area and residential areas. The waste water was not improper treated and directly discharge into the river and made water polluted. The residents also practice unsystematic removal rubbish where there is lots of rubbish in the river. This attitude will contribute to the presence lots of pathogenic and also bacteria, and as well as we know the presence of bacteria will contribute with the presence of diseases to the human.

5.2 RECOMMENDATIONS

The precautions should be taken not by government only but the publics should care about the cleanest of river water to prevent the water quality of Galing River become more polluted in future. There are some recommendations that can be considered by the responsible parties:

1. The local authority must strict in enforcing the Environmental Quality Act 1974 to protect the river. The worker in industrial areas are not understand and realized with this act even they know about this act they are not really concern because there is no responsible parties enforce this act at industry area. The publics should concern with this act in the way to care the cleanest of river water.

2. Due to the industrial area, the waste water must be treated in the right way before discharge into the river. Suppose, the responsible officer must observe the treatment process of waste water before discharge into the drain. There was a parameter limit for sewage and industrial effluents that must be follow it was regulate in Environmental Quality (Wastewater and Industrial Effluent) 1978.

3. Improve the public understanding and participating in prevention of river pollution. The responsibility in protection and maintaining the quality of river water contribute with all parties included government sector, private sector and also publics itself. Cooperation is important to implement the program of prevention of river pollution. The publics must realize that, all this because the benefits for our next generation in the future.

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APPENDIX

APPENDIX A

STANDARD METHOD BY NWQS AND WQI

SUB-INDEX TO USE IN WQI FORMULA

Sub-index for DO (in % saturation):

$SIDO = 0 \text{ for } DO < 8$

$= 100 \text{ for } DO > 92$

$= -0.395 + 0.030DO2 - 0.00020DO3 \text{ for } 8 < DO < 92$

Sub-index for BOD:

$SIBOD = 100.4 - 4.23BOD \text{ for } BOD < 5$

$= 108e\text{-}0.055BOD - 0.1BOD \text{ for } BOD > 5$

Sub-index for COD:

$SICOD = -1.33COD + 99.1 \text{ for } COD < 20$

$= 103e\text{-}0.0157COD - 0.04COD \text{ for } COD > 20$

Sub-index for AN:

$SIAN = 100.5 - 105AN \text{ for } AN < 0.3$

$= 94e\text{-}0.573AN - 5 \tfrac{1}{2} AN - 2 \tfrac{1}{2} \text{ for } 0.3 < AN < 4$

$= 0 \text{ for } AN > 4$

Sub-index for TSS:

$SISS = 97.5e\text{-}0.00676SS + 0.05SS \text{ for } SS < 100$

$= 71e\text{-}0.0016SS - 0.015SS \text{ for } 100 < SS < 1000$

$= 0 \text{ for } SS > 1000$

Sub-index for pH:

$SIpH = 17.2 - 17.2pH + 5.02pH2 \text{ for } pH < 5.5$

$= -242 + 95.5pH - 6.67pH2 \text{ for } 5.5 < pH < 7$

$= -181 + 82.4pH - 6.05pH2 \text{ for } 7 < pH < 8.75$

$= 536 - 77.0pH + 2.76pH2 \text{ for } pH > 8.75$

Table A1: Standard of National Water Quality Standards for Malaysia (NWQS)

Parameters	(Units)	Classes					
		I	IIA	IIB	III	IV	V
Ammonical Nitrogen	mg/l	0.1	0.3	0.3	0.9	2.7	> 2
BOD	mg/l	1	3	3	6	12	> 12
COD	mg/l	10	25	25	50	100	> 100
DO	mg/l	7	5 - 7	5 - 7	3 5	< 3	< 1
pH	-	6.5-8.5	6.5 - 9.5	6 - 9	5 - 9	5 - 9	
Colour	TCU	15	150	150			
Electrical Conductivity	mmhos/cm	1000	1000		-	6000	-
Floatables	-	N	N	N	-	-	-
Odour	-	N	N	N	-	-	-
Salinity	%	0.5	1	-	-	-	-
Taste	-	N	N	N	-	-	-
Total Dissolved Solids	mg/l	500	1000	-	-	-	-
Total Suspended Solids	mg/l	25	50	50	150	300	> 300
Temperature	°C	-	Normal -2	-	Normal -2	-	-
Turbidity	NTU	5	50	50	-	-	-
Faecal Caliform*	counts/100ml	10	100	400	5000 @ 2000	5000 (2000)	-
Total Coliform	counts/100ml	100	5000	50000	50000	50000	>50000
P	mg/l	Natural Lvl.	0.2	0.2	0.1	-	Above Class IV

Table A2: Classification Water Quality Index (DOE-WQI, 2005)

Parameter	Class				
	I	II	III	IV	V
AN	< 0.1	0.1-0.3	0.3 – 0.9	0.9 – 2.7	> 2.7
BOD	< 1	1 – 3	3 – 6	6 – 12	> 12
COD	< 10	10 – 25	25 – 50	50 – 100	> 100
DO	> 7	5 – 7	3 – 5	1 - 3	< 1
pH	> 7	6 – 7	5 – 6	< 5	< 5
TSS	< 25	25 – 50	50 - 150	50 - 30	> 300
WQI	> 92.7	76.5 – 92.7	51.9 – 76.5	31.0 – 51.9	< 31.0

Table A3: National Water Quality Standard for Malaysia (NWQS) for heavy metals

ELEMENTS	UNIT	CLASS I	CLASS IIA/IIB	CLASS III#	CLASS IV	CLASS V
Cd	mg/L	N/A	0.01	0.01*(0.001)	0.01	L.A.IV
Fe	mg/L	N/A	1	1	1(leaf)5(others)	L.A.IV
Mn	mg/L	N/A	0.1	0.1	0.2	L.A.IV
Pd	mg/L	N/A	0.05	0.02*(0.01)	5	L.A.IV
Zn	mg/L	N/A	5	0.4*	2	L.A.IV

* = At hardness 50 mg/l $CaCO_3$

\# = Maximum (unbracketed) and 24-hour average (bracketed) concentrations

N/A = Natural level or absent

L.A.IV = Level above class IV

Table A4: Atomic Absorption Concentration Range with Direct Aspiration Atomic Absorption

ELEMENTS	WAVE LENGTH (nm)	FLAME GASES *	INSTRUMENT DETECTION LIMIT (mg/L)	SENSITIVITY (mg/L)	OPTIMUM CONCENTRATIOON RANGE (mg/L)
Cd	228.8	A-Ac	0.002	0.025	0.05 – 2
Fe	248.3	A-Ac	0.02	0.12	0.3 – 10
Mn	279.5	A-Ac	0.01	0.05	0.1 – 10
Pd	283.3	A-Ac	0.05	0.5	1 - 20
Zn	213.9	A-Ac	0.005	0.02	0.05 – 2

*A-Ac = air-acetylene

APPENDIX B

PICTURES OF APPARATUS

FOR IN-SITU TEST

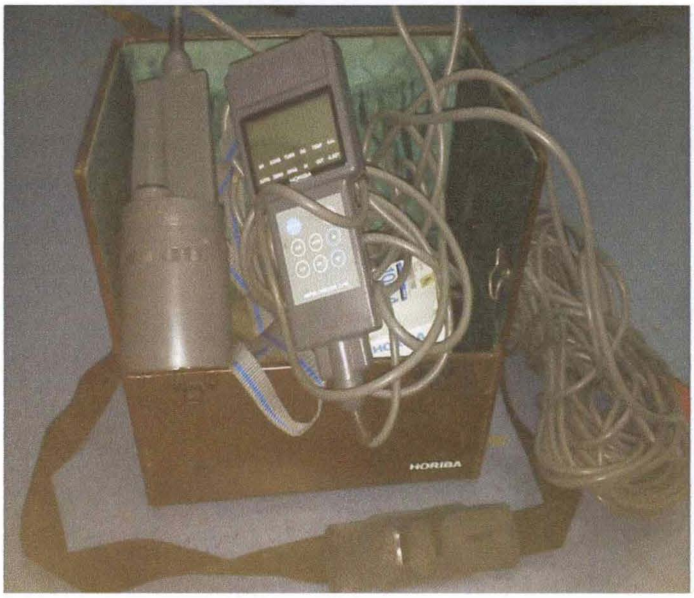

Figure B1: HORIBA multi parameter water quality

FOR LABORATORY TESTS

Total suspended solids

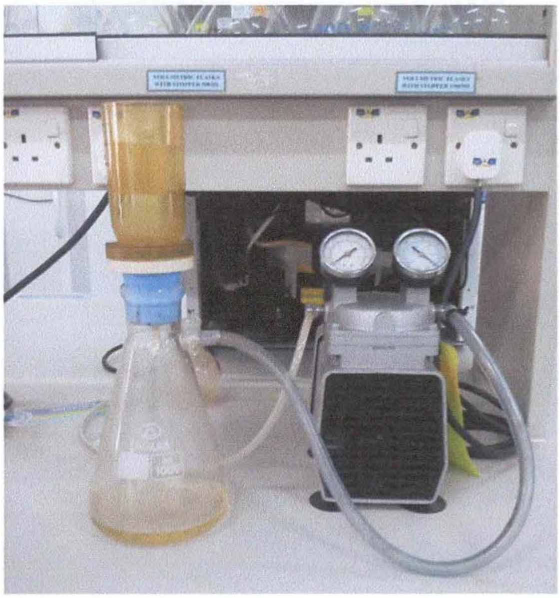

Figure B2: Glass microfiber filter disc with 1000 mL suction flask

Figure B3: Drying oven

Figure B4: Desiccator

Biochemical oxygen demand test

Figure B5: Dissolved oxygen meter

Figure B6: Dilution water

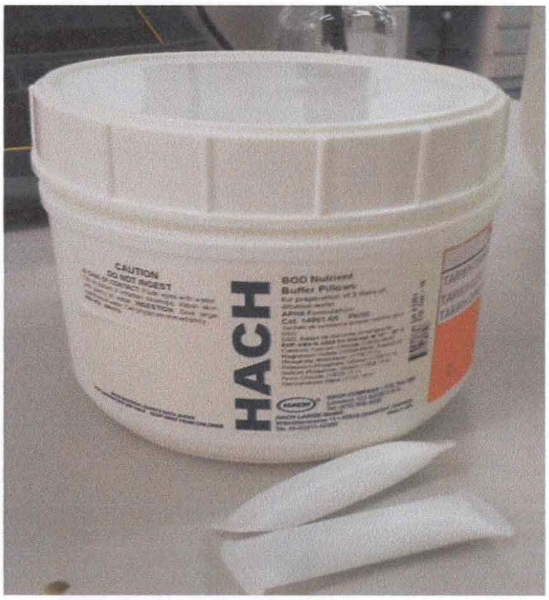

Figure B7: BOD pillow

Figure B8: BOD bottle

Figure B9: Incubator

Chemical oxygen demand

Figure B10: Low range COD vial

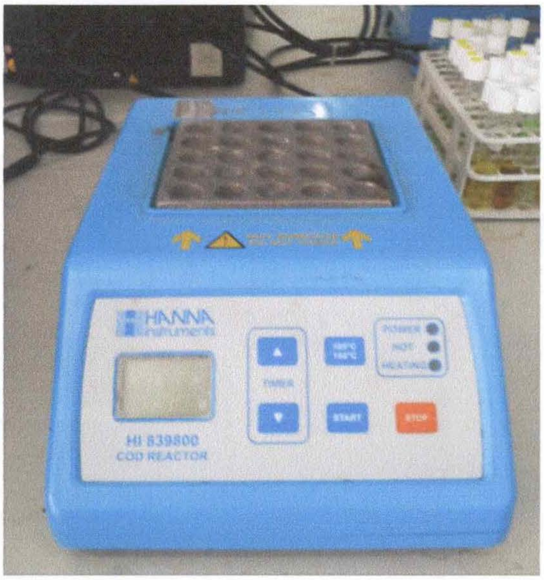

Figure B11: COD reactor

Figure B12: DR 5000 Spectrophotometer

Heavy metal tests

Figure B13: Atomic Absorption Spectrophotometer

Total coliform and Escheriachia coli

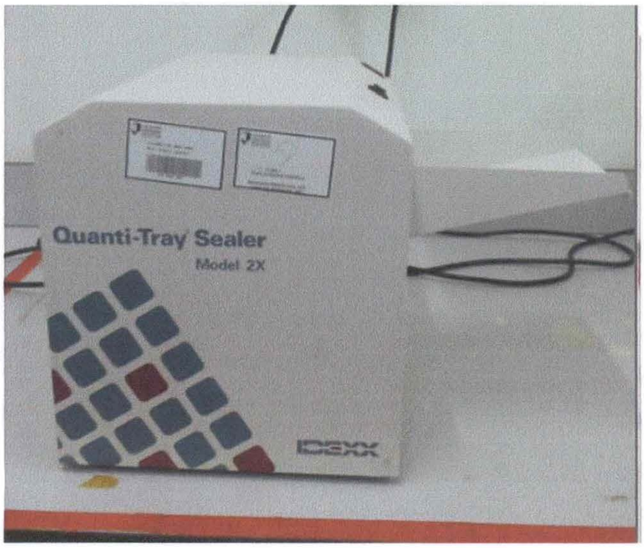

Figure B14: Quanti-tray sealer

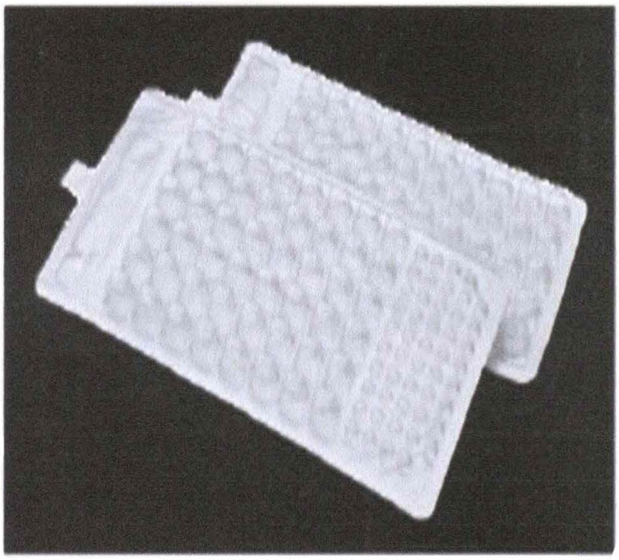

Figure B15: Quanti- tray

Figure B16: Incubator

Figure B17: Colilert

APPENDIX C

RESULT BASED SCORE IN WQI

Table C1: The score of WQI in September 2013

STATION	SCORE	CLASS
1	38.84	IV
2	29.76	V
3	37.21	IV
4	31.32	IV
5	39.70	IV

Table C2: The score of WQI in October 2013

STATION	SCORE	CLASS
1	39.24	IV
2	35.84	IV
3	39.15	IV
4	27.70	V
5	38.81	IV

Table C3: The score of WQI in November 2013

STATION	SCORE	CLASS
1	37.83	IV
2	33.33	IV
3	38.37	IV
4	31.41	IV
5	41.37	IV

Table C4: Result for all parameter at different stations

PARAMETER	UNITS	STN.1	STN.2	STN.3	STN.4	STN.5
Temperature	°c	27.33	27.83	28.5	28.67	29.17
Turbidity	NTU	178	177	150	181	149
TSS	mg/L	17.33	37.67	21.67	82.67	20.67
pH	-	7.30	7.37	7.47	7.39	7.49
DO	mg/L	5.86	5.38	5.63	4.40	4.15
BOD	mg/L	10.02	14.80	12.09	14.48	10.74
COD	mg/L	151.67	230	131.67	200	106.67
AN	mg/L	5.37	6.90	8.68	8.12	5.17
Fe	mg/L	2.091	3.970	1.619	0.916	1.437
Cd	mg/L	0.036	0.026	0.035	0.039	0.035
Zn	mg/L	0.046	0.021	0.043	0.037	0.018
Mn	mg/L	0.063	0.132	0.087	0.069	0.029
Pd	mg/L	0.681	0.713	0.702	0.723	0.738
TC	Count/100ml	684.4	789.5	714	818.3	619.2
E-coli	Count/100ml	519.5	759.7	677	801.53	618.5

APPENDIX D

FIGURE OF SAMPLING STATIONS

Figure D1: Station 1 (Industry Area at Semambu)

Figure D2: Station 2(Residential area at Jalan Haji Ahmad)

Figure D3: Station 3(Residential area at Lorong Galing 9)

Figure D4: Station 4 (Commercial area at Lorong Seri Kuantan)

Figure D5: Station 5 (Tributary at Perkampungan Tanjung Api)