ADVERSE EFFECT OF ANTHROPOGENIC ACTIVITIES ON WATER QUALITY OF THE PEKAN RIVER

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this report is adequate in term of scope and quality for the award in the B. Eng. (Hons) Civil Engineering.

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I hereby declare that the work in this report is my own except for quotations and summaries which have been dully acknowledged. The thesis has not been accepted for any degree and is not concurrently submitted for award of other degree.

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DEDICATION

To my parents, Encik Rosli Hasan and Puan Sabrinah Razak,
friends and my partner.

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ABSTRACT

A study on anthropogenic activities and water quality was carried out in the Pekan river, taking into account the location of the river which is at the centre of the Pekan city. The objectives of the study were to evaluate the water quality based on National Water Quality Standard (NWQS) and Water Quality Index (WQI) Malaysia of surface water quality in the Pekan river, and to identify the sources of pollution for sustainable management in the Pekan river. Three stations have been chosen to be tested its surface water condition. Station 1 was at the upper stream, and Station 3 on the downstream. Data of six in-situ parameters were collected; dissolved oxygen (DO), temperature, pH, electrical conductivity (EC), turbidity and salinity. The other parameters such as total suspended solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (AN), Sulphate, Phosphate and Heavy metals were test in laboratory. The results showed that BOD value was higher on Station 1 (11.02 mg/l) compared to other stations. The BOD value of the Pekan river was higher than the NWQS threshold level. The highest TSS value was at Station 3 (77.75 mg/l). Turbidity on Station 3 was higher (272.5 NTU). Overall, Pekan river was categorized as Class III based on WQI Malaysia, meaning the water cannot be used without proper treatment. The authorities should take action in controlling the condition of the river and establish the awareness of importance of river water among the community

ABSTRAK

Satu kajian mengenai aktiviti antropogenik dan kualiti air telah dijalankan di sungai Pekan, dengan mengambil kira lokasi sungai yang berada di tengah bandar Pekan. Objektif kajian ini adalah untuk menilai kualiti air berdasarkan Standard Kualiti Air Kebangsaan (NWQS) dan Indeks Kualiti Air (WQI) kualiti air di permukaan Sungai Pekan, dan untuk mengenal pasti punca pencemaran untuk pengurusan mampan di Sungai Pekan . Sungai Pekan telah dipilih kerana ia terletak bersebelahan dengan pembandaran di bandar Pekan. Aktiviti antropogenik telah menukar kualiti sungai Pekan. 3 stesyen telah dipilih untuk diuji keadaan air permukaannya. Stesen 1 adalah pada aliran yang paling atas, dan Stesen 3 berada di aliran paling remdah. 6 parameter telah ujian di tapak; Oksigen Terlarut (DO), suhu, pH, kekonduksian elektrik (EC), kekeruhan air dan tahap kandungan garam di dalam sungai. Parameter lain seperti Jumlah Pepejal Terampai (TSS), Permintaan Oksigen Biokimia (BOD), Permintaan Oksigen Kimia (COD), Ammoniakal Nitrogen (AN), Sulphate, Fosfat dan logam berat telah dijalanlan di Makmal Persekitaran. Hasilnya menunjukkan bahawa nilai BOD adalah paling tinggi di Stesen 1 dengan 11.02 mg / l berbanding stesen lain. Hasil BOD sungai Pekan telah dikelaskan dalam Kelas IV jika dibandingkan dengan NWQS. Nilai TSS paling tinggi adalah pada Stesen 3 (77,75 mg / l). Serta hasil untuk kekeruhan, Stesen 3 mempunyai bacaan tertinggi (272.5 NTU). Secara keseluruhan, Pekan sungai dikategorikan dalam Kelas III yang bermaksud air telah dicemari dan memerlukan rawatan jika mahu digunakan sebagai bekalan air minuman. Pihak berkuasa perlu mengambil tindakan dalam mengawal keadaan sungai dan mewujudkan kesedaran mengenai kepentingan air sungai di kalangan masyarakat

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LIST OF ABBREVIATION

AN	Ammoniacal Nitrogen
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
DOE	Department of Environment
EC	Electrical Conductivity
NWQS	National Water Quality Standard
TSS	Total Suspended Solids
WQI	Water Quality Index

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

Water is a well known essential element to human, animals, and many living things on Earth. Water plays important roles in living things and most abundant molecules on Earth's surface that need to be study because of its speciality. One molecule of water contained two hydrogen atoms that covalently bonded to one oxygen atom that produce chemical formula of H_2O. It has many sources of water in the Earth. There are: surface water; water that came from rain or hail that usually collected in catchment, river or lakes; that usually be a community water supplies, springs; water that collected in the bottom of a hills or sloping. Water covers 71% of Earth's surface and most friction of water percentage came from seas and oceans water. Only about 0.3% of water on Earth came from river and lakes.

However this small percentage of water sources may not be neglected their roles in human and living things life. Rivers also play important roles towards living things activities such as use as roads, recreational parks, some rivers produce electric power and also can be used as source of drinking water. One third of the drinking water is come from rivers, lakes and canals.

There is more than 150 rivers system in Malaysia that contributed to 97% of raw water supply source. Even there is a large amount of water, but it is still not enough to

ensure sufficient water supply for Malaysians. This is due to non-uniform temporal and spatial distribution of rainfall. Pollution is the biggest risk to our river. The river water quality obviously has the decline in the environmental health of a river basin. The sources of pollution come from residential, industrial sewerage and effluents from livestock farms, road construction and heavy metals from nearby factories. According to the Environmental Quality Report 2009, 46% river water of Malaysia was polluted which was higher than previous couple of years.

Pekan's river is one of the most important rivers in Pahang state. Along this river, there is lot of human kind's activities such as residential and industrial parks. Along the Pekan river, there are so many human activities that directly and indirectly affect the quality of the Pekan river.

This research is prepared to study on water pollution due to industrial activities and Water Quality Index (WQI) especially in Pekan river, Pahang. Water Quality Index (WQI) is a water pollution indicator that used to determine the physic-chemical parameters of surface water.

1.2 PROBLEM STATEMENT

The quality of rivers water is depending on many factors such as its topography, land use, climate, geology and the biological process. However, there is also another possible factor such as human activities. Many factories built near the rivers to get the river water and used as machinery power or to cool down the machinery. However, there are so many rivers polluted due to industrial activities. The industrial may not properly manage their industrial liquid wastage and drained the wastage into the nearest river. This cause pollution to the rivers and effect their water quality index.

Pekan's river has been chosen as study area in this research due to its fast development around the Pekan area. Many people live around this river and this cause impairment of water quality in this river. People involve directly and indirectly to this river. Hence, this river is very important to the nearest community.

The industrial accidentally discharged the chemical waste product into the Pekan's river. Usually, chemical waste product contained high pollutant substances such as mercury, copper, lead, zinc and cadmium that would cause pollution to the Pekan river water and may affect the living things around the ecology. These substances will increase the water temperature and decreasing the dissolved oxygen level in the Pekan's river. Heavy metals will pose health effect to human beings and aquatic life. The underwater life that exposed to heavy metals pollutants will affect its reproduction rates and life spans.

Therefore, it is important to determine the pollution level and find the sources of pollution in order to recommend the solutions to this problem. The recommend solutions may be useful for river quality in future.

1.3 OBJECTIVES OF THE STUDY

The objectives of the study are as follow:

- To classify the water quality on the Sungai Pekan based on National Water Quality standard (NWQS) and Water Quality Index (WQI) Malaysia.
- To identify the sources of pollution for sustainable management in the Pekan river.

1.4 SCOPE OF STUDY

The scope of study area is Pekan river that is located in south of Kuantan, Pahang. Pekan's river was chose due to fast development along the river by human kind activities. Pekan's river has rapidly urban development and there is lot of sources of river pollution such as surface runoff, industrial activities, municipal waste and agricultural. The purpose of this study is to identify the sources of pollution for sustainable management in the Pekan river. Besides, this research also to classify the water quality based on Malaysian National Quality standard and Water Quality Index (WQI). The study parameters are Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Ammonia Nitrate, Sulphate ,

Phosphate, Suspended Solid (SS), turbidity, heavy metals, temperature, electrical conductivity and pH value. River classification will follow the DOE-WQI. The samples will be examined at field and laboratory. Six parameters that will be tested in-situ are Dissolved oxygen (DO), turbidity, temperature, pH value and electrical conductivity and salinity. The other parameters such as BOD, COD, Ammonia Nitrate, heavy metals, and SS will be tested in laboratory. In order to doing all this testing, Environmental Laboratory on CERRM Lab will be use.

1.5 SIGNIFICANT OF STUDY

The significant of this study are:

i. To analysis the pollution level at the Pekan River, hence determine the source of the pollution itself.
ii. To know the current condition of the water quality of the Pekan River and prepared the precaution steps for any possible adverse.
iii. To establish the awareness in community about the importance of river water's quality in their daily life.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

Water is a crucial element in the living things life. A human can live without foods, however cannot survive without water. Water consists of chemical substances with chemical formula H_2O. The speciality about water is it can be found in three different states; solid, liquid and gas. Hydrologic cycle explains the connections between water in atmosphere, hydrosphere and lithosphere (Myles. R, 2002). Hydrologic cycle explains the movement of water on earth. The constant water is evaporating into the surrounding such as from rivers, ocean, or streams. When the surrounding or atmosphere cannot longer bear with the moisture in the clouds, it will come out in form of rain, snow hail or sleet. However, some water will trap in the ice form. Water melts during the spring and produce run off, that absorbed into the groundwater, or flow into the sea again.

However, nowadays there are too many pollutions that happen on our country especially water pollution and industrial pollution. This pollution is damaging the Earth and living things activities. According to Seeboonruang,U (2012), all this pollutions is due to the increasing of growth population that happen worldwide. The increasing of population also increased the needed in goods supply. Logically, industrial activities also increase hence the water pollution become worst.

2.2 ANTHROPOGENIC ACTIVITIES AND POLLUTION

Anthropogenic activities defined as process, objects, or materials that came from human activities or behaviour that harm the natural environments. These anthropogenic sources may come from industrial, mining activities, construction, habitations or agriculture. Industrial pollution is one of the main causes of pollution in the world. Because of its scope and needed among the worldwide, this worse the situation especially in nation which are rapidly industrializing such as Malaysia. According to Hossain M.A et al. (2013), the anthropogenic activities led to the main caused of water pollution

Nowadays, the demand is exceeding the supply. Hence, industries have to increase their consumption and meet people's need. The increasing of products consumption led to increasing of wastage. The problems arise when this wastage is not managed properly. The quality of surface water is threatening by the various wastewater that release to the land use (Seeboonruang,U, 2012). However, according to Earnhart (2013) the industrial wastewater discharges has been decreasing since early 1970s in develop country but still not cost-effectively due to monitoring and controlling of effluent limits.

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2.3 RIVER WATER POLLUTION

Since decade ago, water pollution is one of the most critical conflicts that happen in many develop country. Many of the main rivers in developing countries face the degradation of the water quality (Schaffnera et all, 2009, Sartor et all, 1974). This is due to their urbanization and fast development. Precisely, the water pollution can happen because of urban runoff. Urban runoff may lead to a variety of conflicts, including pollution when receiving water directly, overloading the treatment facilities, improperly management of waste, and various pollutants contained in the runoff itself. In urban area, rainfall runoff is defined as storm water is one of the major pollution because this type of runoff usually polluted with car oil, dust and faeces of animals, while for industrial areas it contained chemicals and toxic.

2.3.1 Sources Of Water Pollution

Water pollution can be categorized as point source and non point source. Point source is defined as single and identifiable sources of pollution. Pollution that happen because of municipal waste discharges and industrial wastages. Usually this type of pollution can be measured, identifiable of the locations and enter the transport routes at discrete. While non point sources is difficult to measured, has multiple discharge points and unidentified. It occurs when rainfall or irrigation is drainage to the water resources. This type of sources usually associated with land and soil. ((Darradi et al, 2012, Hao et al 2004).

2.3.2 Point Sources

Here are the examples of point sources of pollutions:

- Effluent from a factory that contained chemicals pollutants and directly released into the water or air.
- Chemicals that directly drained into the water without proper treatment.
- Waste oil from car workshop that dumped into the ground and contaminates the soil.
- Agricultural wastes that come from fertilizers.

2.3.3 Non Point Sources

No- point sources came from rainfall runoff that moving into the ground. As the runoff moving, it also carries the natural and unnatural pollutants and brings them into the river or lakes. Here are the examples of non-point sources of pollutions:

- Vehicles engines that produce variety of chemicals product such as oxides of nitrogen.
- Fuel burning with high sulphur dioxide content.
- Acid rain that harmful to aquatic life.
- Urban runoff pollutions.

- Construction site that has poorly management

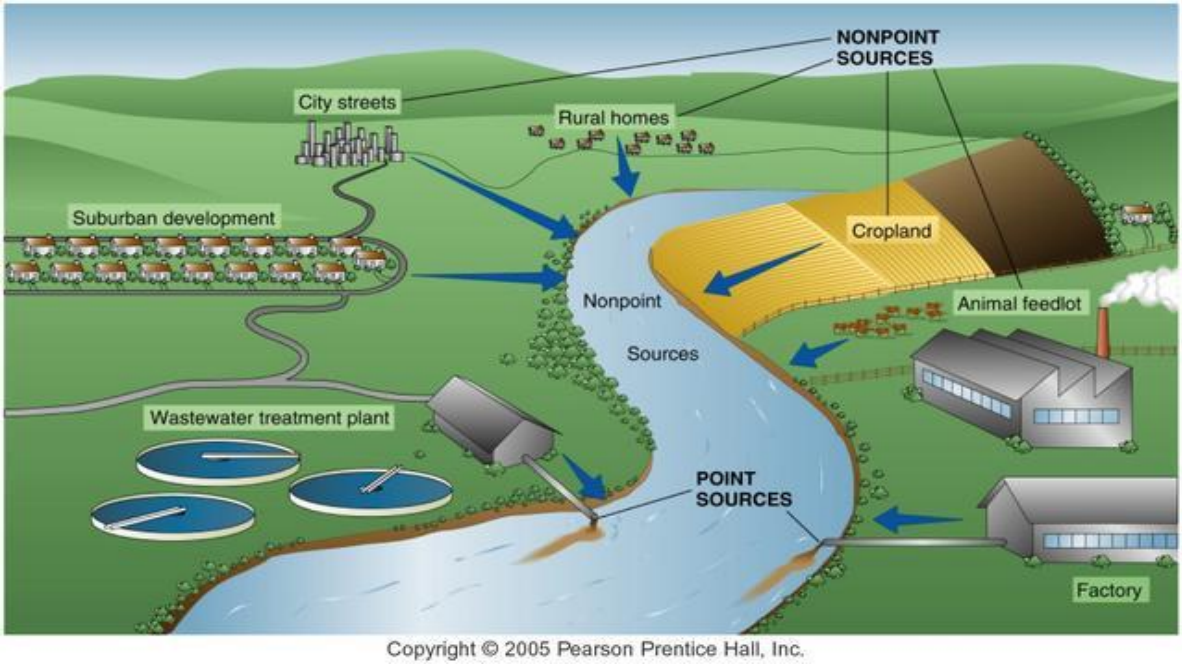


Fig 2.3.1: Point sources and Non- Point sources

2.4 WATER QUALITY CLASSIFICATION

Water Quality Index has been used by Department of Environment (DOE) to evaluate the quality level of river water. WQI is one of the effective's tools to gain the feedback about water quality (M.A Hossain et all, 2013). According to DOE, in 2006 there is 1064 of water quality monitoring station has been located within 146 of river basins. 619 stations (58%) of them were found to be clean, 359 (34%) is slightly polluted and the rest which is 86 (8%) polluted. In this research, they found that stations on upstream is much clean than downstream.

There are five (5) classes on WQI and Interim National Water Quality Standards for Malaysia (INQWS). In our country, WQI is computed by using six parameters which are DO, BOD, COD, SS, AN, and pH. The class of water quality is separated by Class I, II, III, IV or V. Their scale is from 0 to 100 and the highest represent cleaner water (ASMA,2004).

2.5 PARAMETER

In this research, there are few parameters that will be tested to determine the water quality of the Pekan's river. There are pH, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS) Ammonia Nitrate (NH_3), sulphate, phosphate, temperature, turbidity, electrical conductivity and heavy metals.

2.5.1 pH Value

A pH test is to determine the alkalinity and acidity of the water. A neutral pH value is 7, below 7 is acidic and above 7 is alkaline. For most neutral water will have pH value from 5.0 to 8.5. pH of water samples usually can be determined on site or determined in laboratory. Aquatics lives are depend on certain pH value of water to get their optimal life. Some aquatic life will die if the pH value of water is change, even slightly.

A pH on stream will vary depend on a few factors. One of the factors is the bedrock and soil composition where water moves, which are on bed and its groundwater. Some of rock types will have effect on pH value. For example, limestone can neutralize the acids, while granite has no effect on pH value.

The other factors is the amount of organic and plant growth in the water. The quantity of this growth has effect on pH value. When this material is decomposed, they will release carbon dioxide. This carbon dioxide will mix with water and form carbonic acid. Even the carbonic acid is a weak acid, however the large amounts of it will also affect the pH by lowering it.

Next factors are the removal of the chemicals wastages into the water. Every product has its own chemical composition and when this chemical is throwing into the water, the pH value will change along with other chemical parameters of water. Many of industries process need water with exact pH value and add the chemicals to change

the pH to achieve their needs. Then they will discharged this altered pH water as an effluent and this polluted the water.

Another factor that effect the pH is the quantity of acid precipitation that falls into the water. Acid rain is caused by nitrogen oxides (NO_x) and sulphur dioxide (SO_2) that combined with water vapour in the air. When this rain is fall into the water, they will combine with chemical parameters in the water and change the pH value.

2.5.2 Dissolved Oxygen (DO)

Source of oxygen come from many ways, however the biggest source is oxygen that absorbed from the atmosphere. Second largest source is by aquatic plants, which are from algae and photosynthesis of plant. The dissolved oxygen test is to determine the amount of oxygen that dissolved in the water. Oxygen is needed in living things; human, plants and animals. Oxygen is measured as dissolved form as Dissolved Oxygen (DO). If more oxygen is needed than produced, DO levels will decrease and it can be harmful to the fish and other aquatics life. In other word, if there is high level of oxygen in water, it can decrease the aquatic life. Total concentration of dissolved gas in water must not exceed 110% because if the concentration higher than this number, it can be dangerous to the aquatic life.

The deficiency of DO shows unhealthy rivers. There are so many factors that affect Do levels. Waves of water can mix the atmospheric oxygen with river water. Besides, rooted aquatic plants and algae can produces oxygen by photosynthesis process.

Cold water has more oxygen than warm water. Water with high salt concentration will have lower DO concentration even at same temperature with fresh water. Low DO concentration is caused by too much algae production. The algae growth is effected by phosphorus. Dissolved oxygen amount usually determines the number and types of aquatic life that living in the water.

DO concentration is affect by this factors :

- Atmospheric pressure – higher atmospheric pressure on water will make higher DO concentration.
- Plant growth – growth of population will increase the photosynthesis. Higher photosynthesis will have higher DO concentration.
- Temperature – DO level decrease if temperature increased.
- Turbulence – increased turbulence of water will increased the DO concentration.

2.5.3 Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand test used to measure the quantity of oxygen need by microorganism to decompose the organic materials. It is also includes the oxygen needed for oxidation process of various chemical in water.BOD only measures the amount of oxygen consumed by ecosystem oxidation and most used in rich organic matter water. BOD test is measured by taking the value of dissolved oxygen (DO) of the latest sample and compared to the previous sample taken a few days before. The difference of the oxygen reading will be recorded in units of mg/L.

Urban runoff carry several of wastes from street, nutrients from fertilizers, dead leaves, human kind activities will increase the oxygen demand. BOD affected the DO level in the water. the higher the BOD, more fast oxygen is run down in the stream. In other words, less oxygen is available to higher forms of aquatic life. If BOD is too much higher, the aquatic life will die.

2.5.4 Chemical Oxygen Demand (COD)

Chemical Oxygen Demand (COD) test is usually used to measure the amount of organic compounds in water. In other words, the value of COD indicates the amount of oxygen needed for the organic substances to oxidize in the water. Usually COD used to gain the amount of organic pollutants in surface water. This makes the COD an important element in determination of water quality.

The procedure of COD test based on decomposition of chemical of organic and inorganic contaminants either suspended or dissolved in water. The result of this test indicates the water-dissolved oxygen amount which is expresses as parts per million that consumed by contaminants. The higher the COD shows that higher polluted the water.

2.5.5 Total Suspended Solid (TSS)

Total suspended solid is a particle that bigger than 2 microns that found in the water. Most of suspended solids are made up from inorganic materials. Bacteria and algae may also contribute to total solids concentration. Total suspended solid used to measure the turbidity of the water. This is because, suspended solids may turned the water to be milky or muddy looking due to scattering of light from small particles. pH and other qualities of water measurement cannot be seen, however this Suspended Solid can be observed directly. Polluted water will have higher turbidity level compared to clean water because contained unsettled fine suspended mineral. Due to Ali Hannouche et al. (2011) the suspended solid has strong linear relationship with turbidity, however it is varies on the weather and condition of the river itself; dry or wet

2.5.6 Water Temperature

The water temperature is important because it will be create the maximum oxygen holding capacity of water, besides it also has direct influence on rates of biochemical reaction. Temperature will affect both, chemical and biological characteristics. Aquatic organisms are depends on certain temperature for their optimal health. For each organism, there is a thermal death point. If the temperature is exceeding their thermal point, the organisms will die.

All below are the effect of temperature on few elements :

- Dissolved Oxygen - increasing of water temperature will decrease the DO concentration

- Process of chemical - increasing of water temperature will increase the chemical reactions due to solubility of the chemicals.
- Process of biological - metabolism, growth and reproduction also increase when the temperature increase.
- Aquatic ecosystem - aquatic life cannot survive on higher temperature because each aquatic life have their own optimal temperature.

2.5.7 Ammoniacal Nitrogen (AN)

Ammoniacal nitrogen is a determination of the ammonia amount, which is a toxic pollutant that usually found in the landfill leachate, or in the waste product. AN also is a measurement of water quality in natural bodies such as lakes, manmade reservoirs, and rivers. This element commonly used in waste water treatment and system of purification. However, this ammonia can be poison to human and change the equilibrium of water system.

While nitrogen is an essential nutrient for all types of life as a building block for proteins of plant and animal. However, if the nutrient is too much, it will be toxic to the living organisms. The excess present of the nitrogen might cause serious distortions to the natural nutrient cycle among the atmosphere, water and soil. Excessive NH_3 can cause the taste and odour problem to the water system.

Ammonia nitrate is soluble in the water, and produce ammonium hydroxide which is a temporary constituent in water because it is part of nitrogen cycle which affected by biological activities.

2.5.7.1 Source of Ammonia in Rivers

- Released of ammoniacal-rich fertilizer
- Uncontrolled landfill leachate
- Untreated sewerage from farm, factories, septic tanks
- Wastewater effluents from domestic, commercial
- Surface runoff and rainfall

- Municipal sewage

2.5.8 Turbidity

Turbidity is the measurement of water clearness or clarity on how much suspended materials in the water that decreased the passage of light into the water. It is not measure the amount of suspended solids, it only measures the amount of light that is scattered by the suspended solids. Turbidity is cause by suspended solids in the water, either from industrial wastes, clays, silt, sewage or plankton. The particles absorb heat from the sun, thus increasing the temperature. When the temperature is high, dissolved oxygen will decrease because warm water holds less oxygen. Turbidity also reduces the penetrating of light amount into the water, which means the photosynthesis process cannot occur and DO decreases.

Below are the sources of turbidity:

- High iron concentration (that makes the water become rust-red looks)
- Runoff from watershed
- Soil erosion from the bottom
- Product of algae and plant production breakdown
- Water discharges (from industries, municipals or sewage)

2.5.9 Heavy Metals

Due to industrial wastes from the nearest river, there is potential that the water contains heavy metals pollution in the aquatic system. In some environment conditions, heavy metals may cause toxic concentration and destroy the ecology (John G. Dean et all,1992). Some of them such as Manganese (Mg), Iron (Fe) Cobalt (Co), Copper (Cu), Chromium (Cr), and Zinc (Zn) are helping in daily life, while the others such as Mercury (Hg), Arsenic (As) and lead (Pb) are dangerous to the others.

Due to Hamidi A.Aziz et al (2007), heavy metals such as Cd, Pb, Zn, Ni, Cu and Cr has been used extensively in industrial, either in mining activities or chemical industries. Because of this parameter, it has brought the increasing of the water

contamination in Malaysia. The presence of these metals in high quantities will decrease the water quality.

Heavy metals may penetrate the water via natural process such as through rains or flowing water from formation of geological. Industries activities also contributed to this problem. The industrials process possible to generate the heavy metals in large quantities.

Here are the impacts of heavy metals:

- It is bio accumulative, which means it absorbed toxic substance greater than the losses.
- The pH value will decrease by increasing of metal availability.
- It contains toxicity at high concentration.

2.5.10 Electrical Conductivity (EC)

Conductivity is used as determination of salinity of the water besides a measurement of water ability to conduct the electricity. This conductivity is effect by the total dissolved solid (TDS) concentration. The conductivity has been used as indicator in the influence of runoff to and waste water discharge in aquatic.

This conductivity is depending on water temperature, where as the temperature increase, the electrical conductivity also increase.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

This chapter will discuss about ten parameters that conducted in order to achieve the objectives of the study. The ten parameters are pH value, Dissolved Oxygen (DO), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Suspended Solid (TSS), Ammonia Nitrate (AN), temperature, turbidity, electrical conductivity and heavy metals.

DO, temperature, turbidity, electrical conductivity and pH parameters will conducted in situ on site, while the others parameters will be tested in the laboratory. The test will be conducted on samples from the Pekan river water. The sampling will be taken from different stations, different days and times. Then the result of the tests will be compared with Water Quality Index (WQI) and National Water Quality Standards (NWQS) to determine the river water quality.

3.2 STUDY AREA

Pekan is the one of 14 districts that belongs to Pahang. It is 50 km to the south of Kuantan and located on the banks of Pahang river. Pekan is the Royal Town of Pahang. Pekan town has a fast development in terms of industrial, agricultural, vehicles manufacturers and residential areas. Pekan is one of the high technology cities in

Pahang. Pekan has fast development of human kind activities from agricultural, industrial and residential.

The Pekan river has been chosen as the site of the study due to its characteristics. Pekan river is one of the most important rivers in Pahang state. Along this river, there is lot of human kind's activities such as food courts, petrol stations, and industrial parks. This river also has been chosen due to its fast development along the river with so many kinds of activities such as industrial, agricultural and residential. It has lots of human activities held along the Pekan river.

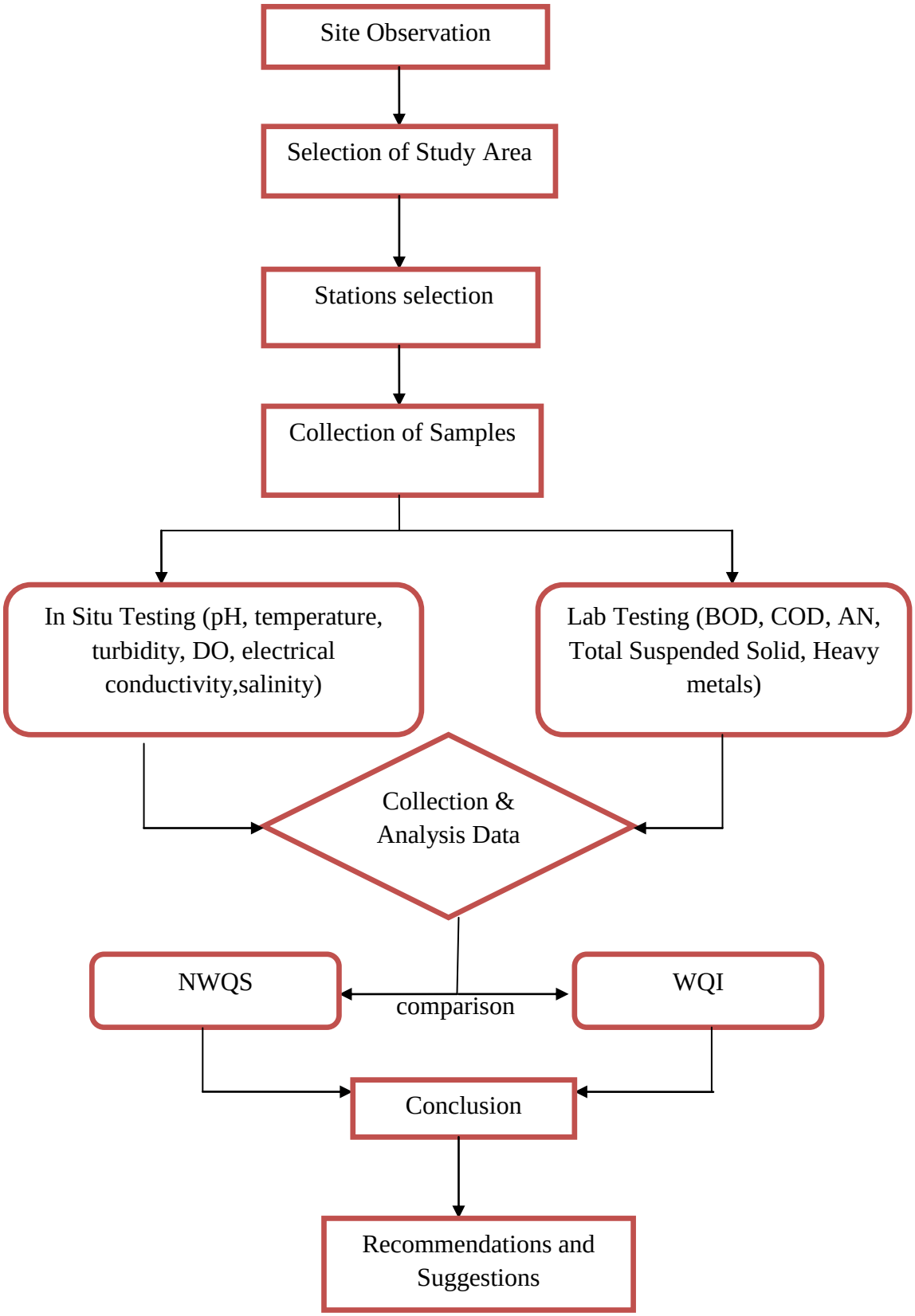


Fig 3.2.1: Flowchart of work sequences

3.3 SAMPLING AREA

The location of the sampling is also depending on the sources of pollution along the area. The pollution occurs in the Pekan river is due to industrial activities and residential areas near the river. The sample will be taken in 3 different places with two sampling on each station and two replicates each time. First sampling was taken on 25th February 2015, while second sampling on 2nd April 2015, which about a month after first sampling.

3.4 WATER QUALITY INDEX

Water Quality Index (WQI) is computed based on 6 main parameters which are:

1. pH
2. Dissolved Oxygen (DO)
3. Biochemical Oxygen Demand (BOD)
4. Chemical Oxygen Demand (COD)
5. Total Suspended Solid (TSS)
6. Ammonia Nitrate (AN)

WQI is measured by using Equation 3.4.1

$$\mathbf{WQI = 0.22\,(SI\ DO) + 0.19\,(SI\ BOD) + 0.16\,(SI\ COD) + 0.15\,(SI\ AN) + 0.16\,(SI\ SS) + 0.12\,(SI\ pH)} \quad \text{(Eq 3.4.1)}$$

3.5 PARAMETERS TEST

3.5.1 Dissolved Oxygen (DO)

The equipment used to measure the dissolved oxygen (DO) is Horiba U-10 Water Quality Checker. This equipment will give the direct reading of the dissolves oxygen results in the sampling. With the accurate reading, this easy push-button

operation equipment will give the fast result by submerged the equipment into the water sample.

3.5.1.1 Procedures

1. The equipment will be rinsed with distilled water before used, as a precaution step to get the accurate value of result
2. Turn the main unit ON. The U-10 will be in MEAS mode.
3. The last previous data will show up.
4. The sensor must be fully immersed in the water
5. To get the uniform readings, move the probe up and down steadily.
6. The value of DO will be displayed in mg/l unit

3.5.2 Biochemical Oxygen Demand (BOD)

Biochemical Oxygen Demand (BOD) used to indicate the strength of DO amount required to break down the wastewater. It is basically measured the biological and chemical component of waste that needed of DO by aerobic biological system. BOD test is done is specially designated 300 ml bottle with flared cap to avoid the air out.

3.5.2.1 Procedures

1. The sample will be neutralized to pH around 7.0 by using 1 N NaOH or H_2SO_4
2. The dilution water will be prepared in a glass container by bubbling compressed air in distilled water for about 30 minutes. One capsule of BOD nutrient was mixed with 3 litre of distilled water.
3. Then 100ml of sample is measured and poured into BOD bottle.
4. 200ml of dilution water was added into the BOD bottle.
5. The dilutions will be prepared in the bucket, mixed the content thouroughly. The water is filled into the BOD bottles. DO content with oxygen meter is determined and BOD kept in the incubator at 30◦C.
6. The DO is measured after 5 days.

3.5.2.2 Calculation of BOD

To calculate the BOD, used equation 3.5.1

$$BOD = \frac{DO_i - DO_f}{P}$$

Where P : dilution factor

DO_i : initial DO of diluted waste water sample about 15 minutes after preparation

DO_f : final DO of diluted waste water sample after incubation about i day

3.5.3 Chemical Oxygen Demand (COD)

The COD test is used to measures the oxygen that consumed by the organic matters in a samples during strong chemical oxidation. This strong chemical oxidation provided by potassium dichromate as the oxygen source with sulphuric acid concentration added. The COD test is done by using COD Reactor DR/2500 Spectrophotometer that will oxidize the organic matter chemically. This test has strong relation with BOD test.

3.5.3.1 Procedures

1. The quantities of measured potassium dichromate, sulphuric acid reagent containing silver sulphate, and a measured samples volume is added into the flask.
2. The mixture is vaporized and condensed for two hours. This oxidation is turning the dichromate to trivalent chromium.

   Organic matter + $Cr_2O_7^{2-}$ + H^+ = CO_2 + H_2O + $2Cr_{3+}$
3. The mixture then titrated with ferrous ammonium sulphate (FAS) to get the remaining dichromate in the sample.
4. A blank sample of distilled water then is carried through the same COD procedures as the wastewater sample.

3.5.3.2 Calculation of COD

To calculate the COD, used Equation 3.5.2

$$COD = \frac{(8000\ (a-b)}{v} \times \text{Normality of FAS}$$

where a : amount of ferrous ammonium sulphate titrant added to blank,mL
b : amount of titrant added to sample, mL
v : volume of sample,mL
8000 : multiplier to express COD in mg/L of oxygen

3.5.4 Total Suspended Solid (TSS)

TSS is a solid that trapped in the filter. It can include clays, animal matter, waste from industries, sewage or decaying plant. If the concentration is too high, it can cause health problems to the living things. TSS will be measured by using APHA 2450 D.

3.5.4.1 Procedures

1. The filter disc will be inserted into the base and clamp on funnel. The disc will be washed with 3 successive 20ml of distilled water while vacuum applied. All the traces will be removed with continuing vacuum applied after water passed through. The funnel will be removed from base and the filter placed in the aluminium dish and dry in oven at 103◦C to 105◦C for one hour.
2. The sample volume will be selected, with maximum of 200 ml that will yield not more than 200 mg of total suspended solid.
3. The filter will be placed on the base and clamp on funnel and vacuum is applied. The filter will wet with small volume of distilled water to seal the filter with the base.
4. The samples will then shake vigorously and quantitatively transfer 100 ml of sample to the filter by using large orifice, volumetric pipette. All the traces of water are removed by applied the continuous vacuum after sample has passed through.

5. The pipette and funnel will be rinsed onto the filter with small volume of distilled water. All traces of water will be removed by applied continuous vacuum after water passed through.
6. The disc filter will be remove carefully from the base. It will be dry for at least one hour at 103◦C to 105◦C. The samples then cooled in the desiccators and weighed.

3.5.4.2 Calculation of TSS

To calculate the TSS used Equation 3.5.3:

$$\text{TSS,mg/L} = \frac{(A-B) \times 1000}{C}$$

Where: A : weight of filter and dish + residue in mg
B : weight of filter and dish in mg
C : volume of sample filtered in L

3.5.5 Ammoniacal Nitrogen (AN)

Ammonia is a toxic substance even in their low concentration. Aquatics life will be effect by this substance even it has low concentration. This ammonia has poses danger to aquatics living according to the temperature of water and pH. The higher the pH, the warmer the surrounding, ammonia will increase its toxicity. Ammonia also increase its toxicity when there is less dissolved oxygen in the water. Ammonia nitrate will be test by using DR/5000 Spectrophotometer by using Nesler Method.

3.5.6 Turbidity

Turbidity is considered as one of the good indicator in the water quality. Turbidity is a measure of the degree of the water loses its transparency due to the suspended particles presence. The more suspended solid in the water, the milky the water, hence the higher the turbidity of the water. Turbidity is measured by using HACH Turbidity meter.

3.5.61 Procedures

1. A short warm-up period allowed for about 5 minutes for the turbidimeter
2. The turbidimeter will calibrated using the standard turbidity suspensions.
3. The sample will be poured into the sample tube. The air bubbles are avoided from getting in the sample tube
4. The sample will be wipe thoroughly by using tissue paper. Then read the result.

3.5.7 pH And Temperature

For pH and temperature test, they will be testing by using pH and Temperature meter (Horiba Water Analysis Equipment). The detector will be placed in the water, and automatically the value will appear after the device is on On mode. Before that, we need to choose the parameters, either pH or temperature on an adjustable button.

3.5.8 Heavy Metals

Heavy metals are harmful to environment so it is need to be reduced. In this research, heavy metals will be test to know the water quality of Pekan river by using Atomic Absorption Spectrophotometer (AAS) 3110.

Heavy metals that being tested:

1- Copper (Cu)
2- Lead (Pb)
3- Iron (Fe)
4- Zinc (Zn)

CHAPTER 4

RESULTS

4.1 INTRODUCTION

All the results obtained from the test and analysis is compared to the National Water Quality Standard (NWQS) to get the class of the water quality in Sungai Pekan. Water sampling process is run for two times for every station. In this test, three stations was chose as the site sampling. First station is on the lowest stream of the river, second station is at the middle of the stream flow, and third station at the upper stream which are 300m apart from each other.

There are 12 parameters that have been chose to determine the water quality according to NWQS which are Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Dissolved Oxygen (DO), Total Suspended Solid (TSS), pH, temperature, electrical conductivity, turbidity, heavy metals, sulphate, phosphate and ammonia nitrate. For heavy metals parameters, the parameters chosen are Zn, Pb, Cu and Fe.

4.2 SAMPLING PROCESS

The sampling process was done twice, once in the end of February, second time on early of April. Every sampling is taken on three randomly different stations, while every station consist two replicates. To put it into simplest words, three stations with

two replicates each. Each station have gap about 300m with each other. In order to analyse the chemical parameters, 1000ml white bottles were used to collect the water samples. The bottles were labelled according to the stations and replicates. Before used, the bottles were thoroughly rinsed with the river water before samples were taken. All the samples were kept at 4°C until it analysed. For BOD test, 500ml bottles were used and must be fully submerged into the water during the water sampling and must make sure there are no bubbles in the bottles before closed the lid. Certain parameters such as DO, turbidity, pH value, temperature, electrical conductivity, and salinity of water were measured directly in-situ. The following sub will explained the details of each test and parameter measurement.

4.3 IN-SITU PARAMETERS

Focusing on in-situ parameters, all the field measurement is done by mechanical indicator that consist every six of the parameters measurement needed. Field measurement includes temperature, pH, electrical conductivity (EC), turbidity, and dissolved oxygen (DO). Below is the result of each in-situ parameters.

4.3.1 Temperature

Figure 4.1 below shows the result of temperature reading for both sampling measurement. For the first sampling, it is taken at the end of February, 25th February while for the second sampling is taken on 2nd April 2015.

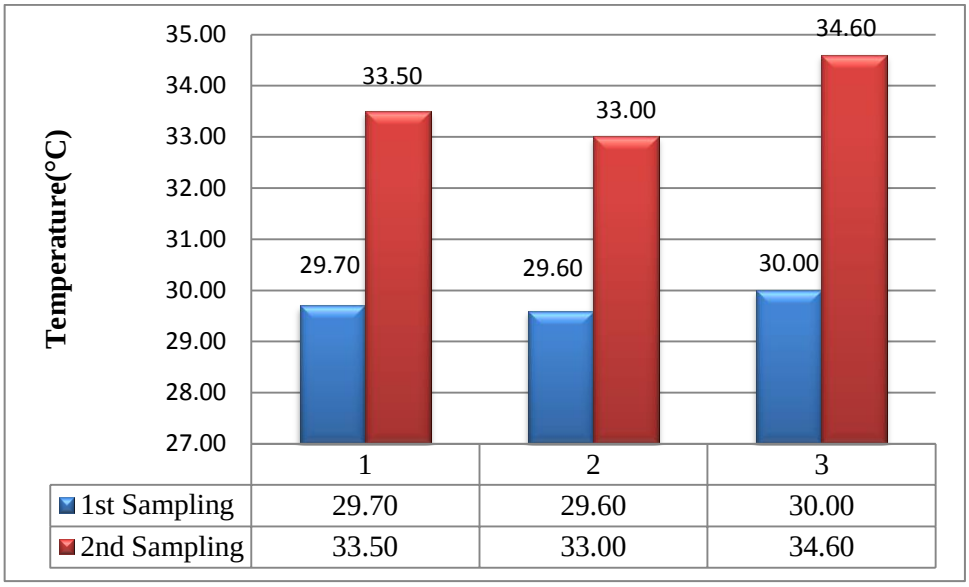
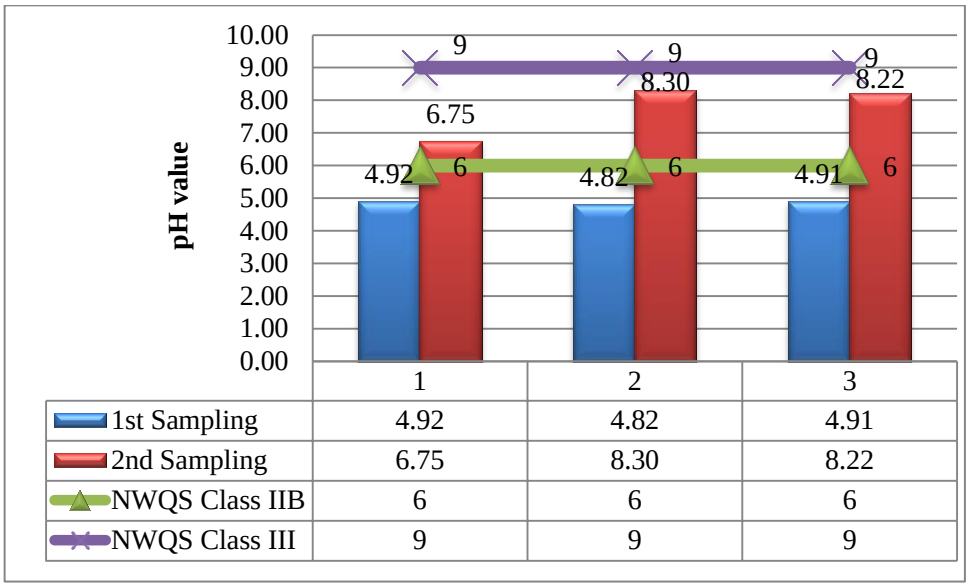


Fig 4.3.1: Sungai Pekan's temperature

The water temperatures were ranging from 29.7°C to 34.6°C. The trend of this temperature obviously indicated an increase in a month sampling process. The increasing of this two sampling was due to the changes of weather in Pekan city.

During second sampling, the weather is sunnier than on the first time sampling. This result more high temperature on second sampling even the stations is still the same. In aspects of stations itself, it shown that Station 3 is always highest in temperature compare to the other stations. This is because, on station 3, the water condition is cloudier than two other stations. Cloudy water effects value of DO because when the temperature is increasing, the DO value will decrease. Water temperature affects almost every other water quality parameters. Cold water can hold more dissolved oxygen compared to warm water.

4.3.2 pH



	1	2	3
1st Sampling	4.92	4.82	4.91
2nd Sampling	6.75	8.30	8.22
NWQS Class IIB	6	6	6
NWQS Class III	9	9	9

Fig 4.3.2: Comparison of pH value

Fig 4.2 shows the comparison of the pH value for three stations by two different sampling process. During first sampling on 25th February, it shows that the water condition is a bit acidic. The range of the pH value for this three station is from 4.82 to 4.92. Station 1 have highest pH value among this three station with 4.92. The lower value is on station 2 with 4.82 that shows more acidic condtion than two other station.

On second sampling process on 2nd April, the pH value range from 6.75 to 8.3. The highest acidic value is on station 1 with reading 6.75. Second sampling shows more alkaline condition in the Sungai Pekan.

pH value was varies according to removal of the chemicals wastages into the water. For every station, the chemical wastages were different due to their different position and drainage. The water flowing is from station 3 to station 1. For example, on station 1, it received wastage from nearest motorcycle workshop. Station 3 receives waste water from areas of eateries and boat harbour. The circumstances surrounding the station 3 is very severe because of the restaurant's waste water discharged directly into drains that connect to the river. While station 2 is in between station 1 and 3, so its condition is stable between this 2 stations.

Overall, it can be concluded that pH on the Pekan river is classified as class III according to national Water Quality Standard (NWQS).

4.3.3 Electrical Conductivity (EC)

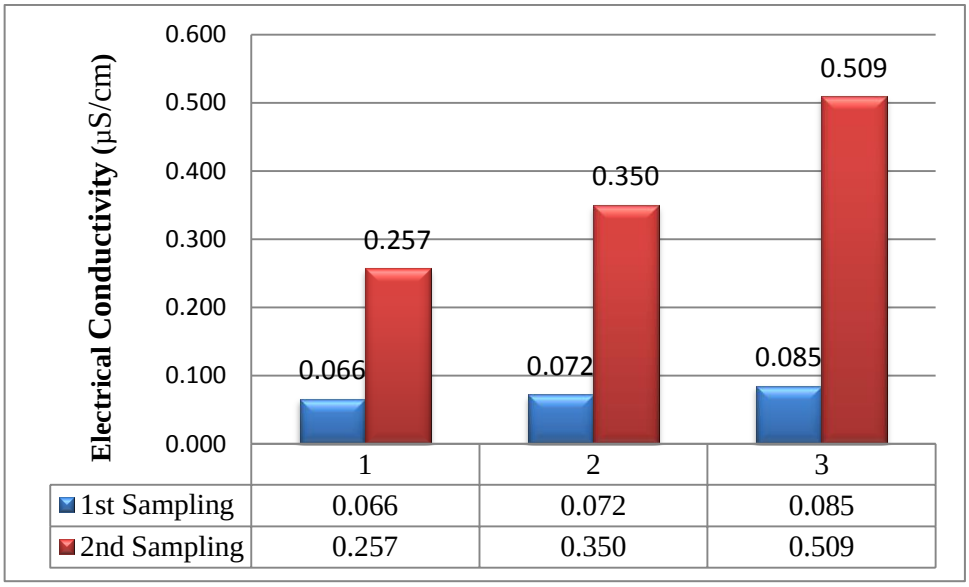


Fig 4.3.3: Electrical conductivity result

Fig 4.3 shows the electrical conductivity of the three stations during 5 weeks apart of sampling. Obviously as shown in the figure, EC for second sampling is much higher than first sampling. EC is a measurement of total amount of the dissolved solid in the water.

On the first sampling, the result shows less EC obtained from all three stations, however on second time sampling, the value is sharply increased. The highest value obtained on Station 3, with 0.509 µS/cm.

EC is depends on the water temperature. The higher the temperature, the higher the EC would be. On the second time sampling, temperature of the water is higher than first sampling. This can explained the increasing of the EC value. EC also depend on the dissolved solid in the water. As dissolved solid increased, EC also increased. EC is a good indicator for salinity, even though it did not provide ion composition information.

Conductivity usually vary with water source, either the water source are water drained from agricultural activities, municipal waste water, rainfall or ground water itself.

Figure shows that on second sampling the value of EC is higher than first sampling. In addition, station 3 showed highest value of electrical conductivities compared to other stations due to its highest turbidity. Highest turbidity indicated highest solid content. Highest solid content will affects the EC. Overall, electrical conductivity on the Pekan river has been classified as Class I.

4.3.4 Turbidity

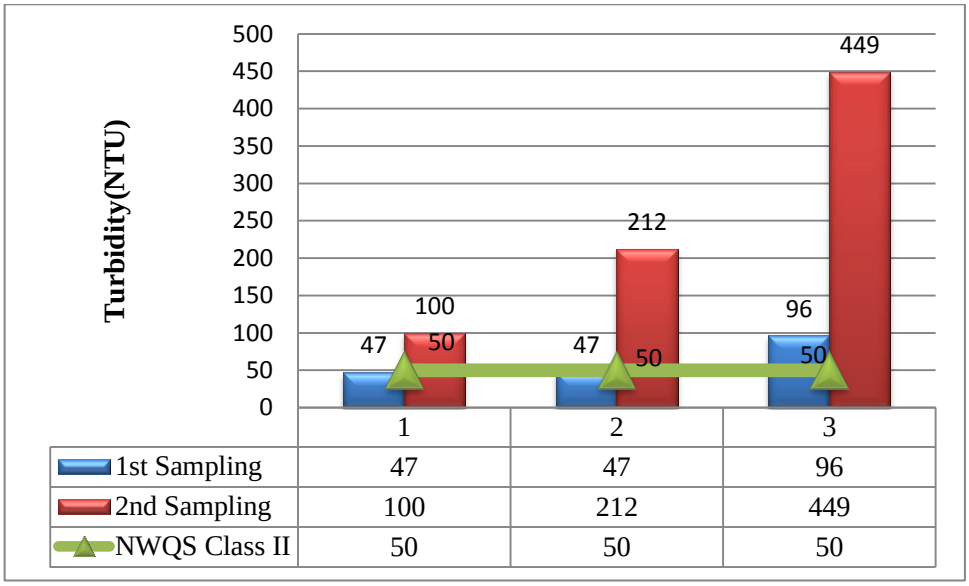


Fig 4.3.4: Turbidity result

Figure 4.4 shows the turbidity result on both sampling. The graph shows that on second sampling, the turbidity value is higher than first sampling. The highest value of turbidity is on station 3, with 96 NTU on the first sampling, and 449 NTU for second time. This is due to many reasons. Station 3 has the cloudier and milky water compared to the other stations. It also has the most dissolved solids.

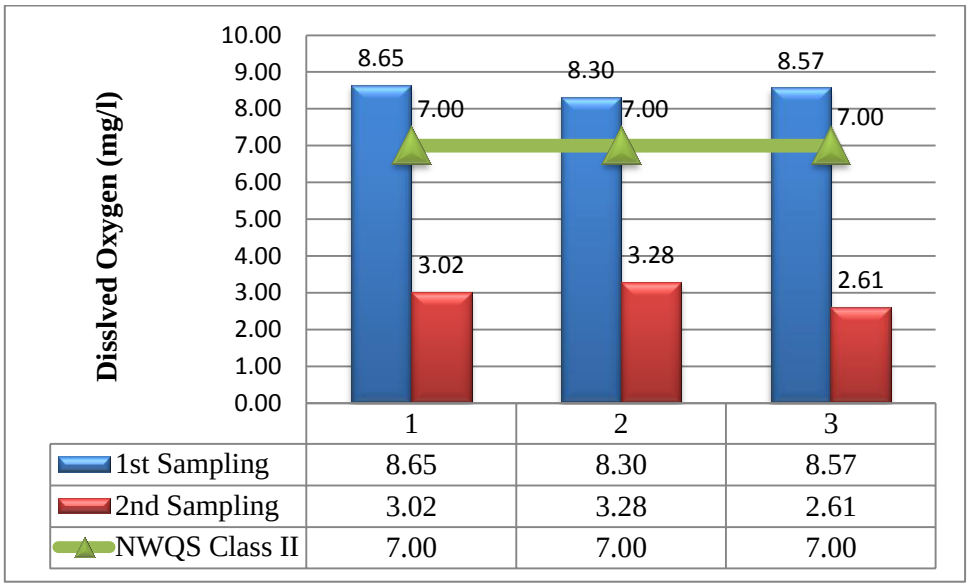
Weather also plays important roles in determining the value of turbidity. Turbidity can be affected by sunnier and hot temperature. The higher the temperature

until the water becomes cloudy and dry, the higher the turbidity value. Turbidity caused by the process of decaying the organic matters.

Turbidity can be related with Total Suspended Solid. When the TSS increased, turbidity also increased. Both indicated the amount of minerals content (soil particles) and organic (algae) in the water.

According to the result, the average value of turbidity on the Pekan river can be considered as Class II compared to NWQS.

4.3.5 Dissolved Oxygen (DO)



	1	2	3
1st Sampling	8.65	8.30	8.57
2nd Sampling	3.02	3.28	2.61
NWQS Class II	7.00	7.00	7.00

Fig 4.3.5: Dissolved Oxygen Result

Fig 4.5 shows that there are dropped in the DO value. As mention before, DO value has correlation with temperature. When temperature is high, the DO value will decreased. Temperature on each station has increased on second sampling, due to the hot weather. So, dissolved oxygen declined on the second sampling. Average DO for Station 1 is 5.84 mg/l, Station 2 5.79 mg/l and Station 3 DO result is 5.59 mg/l.

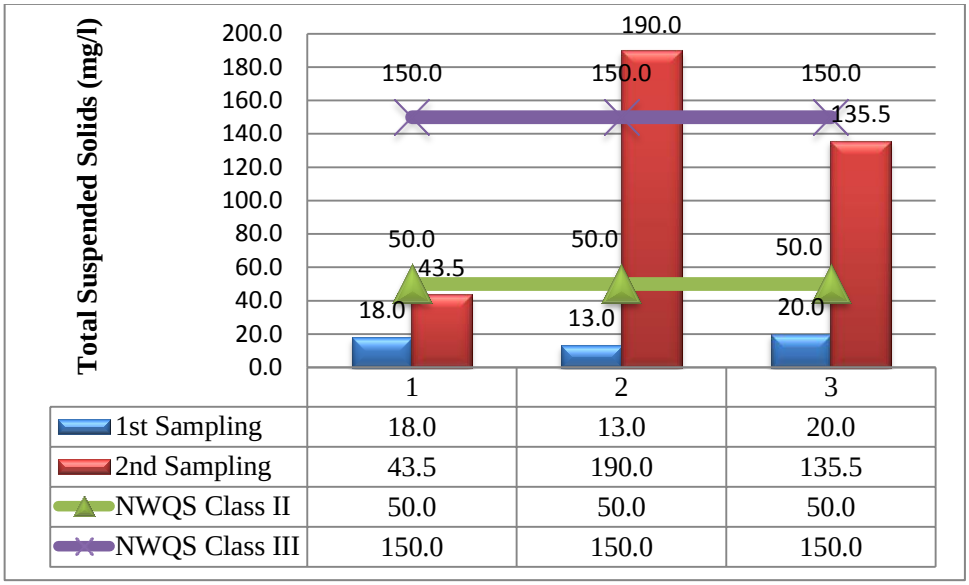
In this case, we can say that DO was affect by the temperature and plant growth. Due to high temperature, water level decrease and make the water move slower, which

caused it less mix with oxygen, so the DO decreased. High temperature contains less dissolved oxygen. Overall, DO for the Pekan river can be concluded as Class II according to DOE-NWQS.

4.4 EX SITU PARAMETERS

For ex situ parameters, all the test and analysis was done at Environmental Laboratory FKASA in UMP. About seven parameters was tested which are Total Suspended Solids (TSS), Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Ammoniacal Nitrogen (AN), Sulphate, Phosphate and Heavy Metals; Pb, Cu, Zn, and Fe. Below is the result of ex situ parameters.

4.4.1 Total Suspended Solids (TSS)



	1	2	3
1st Sampling	18.0	13.0	20.0
2nd Sampling	43.5	190.0	135.5
NWQS Class II	50.0	50.0	50.0
NWQS Class III	150.0	150.0	150.0

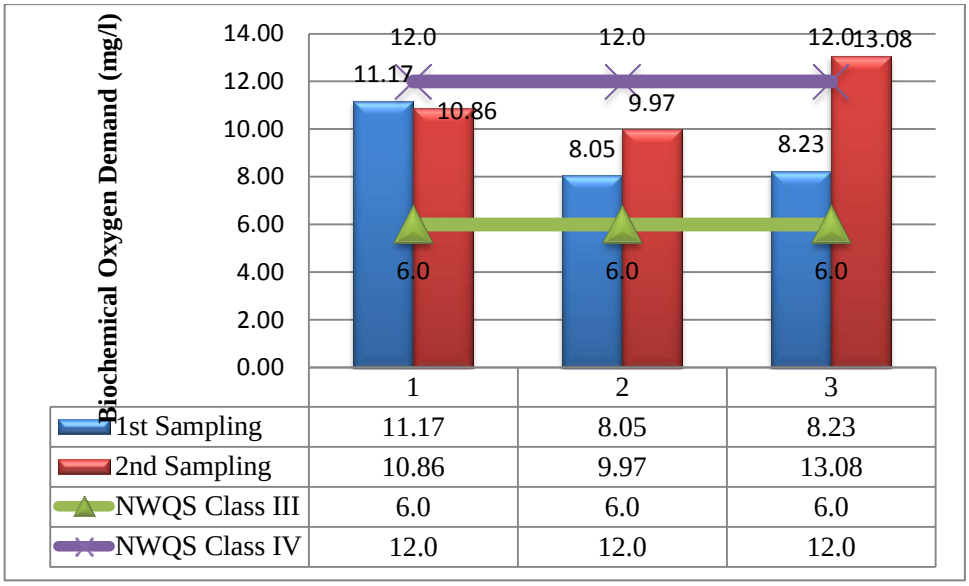
Fig 4.4.1: TSS Result

According to the result, it obviously shows the differences between first sampling and second sampling on every station. On the first sampling, the range of reading was from 13 mg/l to 20 mg/l, while for second sampling it was abruptly change. The values start with 43.5 mg/l on Station 1, 190 mg/l on Station 2 and 135.5 mg/l on Station 3.

The change in this result was due to a few factors, such as temperature and turbidity results. As mentioned before, on second sampling, the weather is more sunny and hot compared to first sampling. The river become low tide, the flow rate of river water decreased. The water became cloudier, especially on station 3. Somehow, the result of TSS shown that the highest reading on Station 2, which supposedly the highest are on Station 3 because of the turbidity result before.

Total suspended solids were affecting by soil erosion from the bed of the river itself that eroded the particles and increases the suspended solids in the water body. As the plant decays, it will compose suspended organic particles and contributed to the suspended solids result. Average result of each station was classified as Class II for Station 1, and Class III for station 2 and Station 3 when compared to NWQS.

4.4.2 Biochemical Oxygen Demand (BOD)



	1	2	3
1st Sampling	11.17	8.05	8.23
2nd Sampling	10.86	9.97	13.08
NWQS Class III	6.0	6.0	6.0
NWQS Class IV	12.0	12.0	12.0

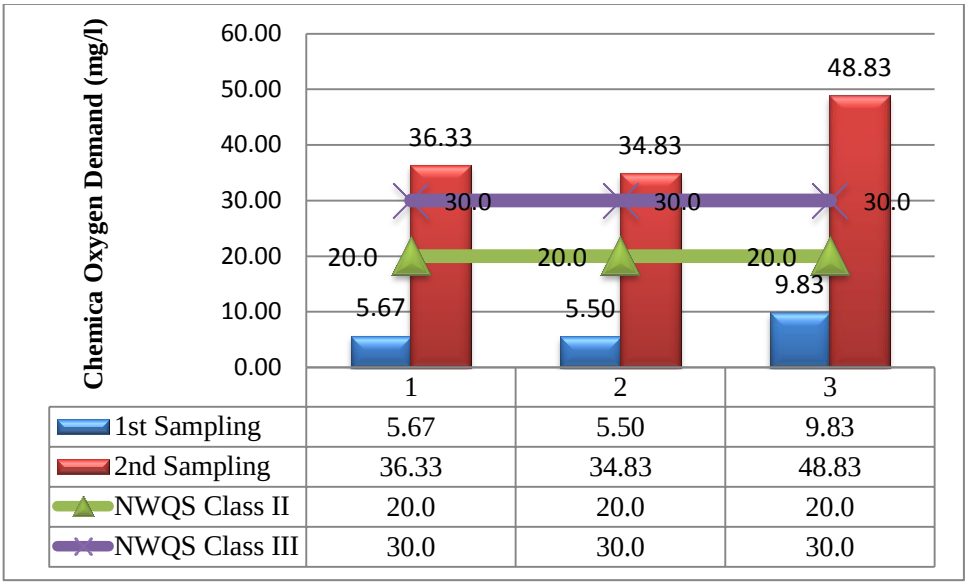
Fig 4.4.2: BOD Result

Fig 4.4.2 shows the result of Biochemical Oxygen Demand (BOD) for three stations. On Station 1, BOD result almost same for both sampling. On Station 2, there was increasing value on the second sampling, while for Station 3 the gap was bigger between first sampling and second sampling. It shows that, the value of each BOD is higher than Class III but less than Class IV in NWQS.

BOD is a measurement of oxygen amount the needed by microorganisms in order to decomposed the organic matter in the water. While DO is the amount of oxygen dissolved in the water. BOD has correlation with DO and COD results. When BOD increased, the value of DO will decrease. When BOD is higher, it means that there are lots of organic contaminated the water. And the microorganisms needs time to break it. They used oxygen to break it, so when BOD is high, the DO will decrease.

Overall, the result of BOD for the Pekan river shows that it was under Class IV which means the water was irrigated, and contaminated. According to Department of Environment (DOE), as the result of BOD is range from 9.0 mg/l to 11.02 mg/l, less that 79 mg/l, it is considered as polluted.

4.4.3 Chemical Oxygen Demand (COD)



	1	2	3
1st Sampling	5.67	5.50	9.83
2nd Sampling	36.33	34.83	48.83
NWQS Class II	20.0	20.0	20.0
NWQS Class III	30.0	30.0	30.0

Fig 4.4.3: COD Result

On the Station 1 sampling 1, the value of COD was 5.67 mg/l, on its second sampling 36.33 mg/l. Quite high difference value. While in Station 2, first sampling was 5.50 mg/l and 34.83 mg/l for second sampling. On the Station 3, first sampling was 9.83 mg/l and 48.83 mg/l on second time sampling. The result was compared with Class II and Class III of COD in the NWQS.

The COD is the value that used to know the oxygen amount needed to oxidize the organic substances in the water. High COD value shows unhealthy sign of the river water body because COD shows the depletion of oxygen capacity in the water. Just like BOD, DO will decrease when COD increase.

Overall result for Chemical Oxygen Demand on the Pekan river shows that on Station 1 and Station 2, the COD was classified as Class IIA, while Station 3 classified as Class III because it has higher COD reading.

4.4.4 Ammoniacal Nitrogen (An)

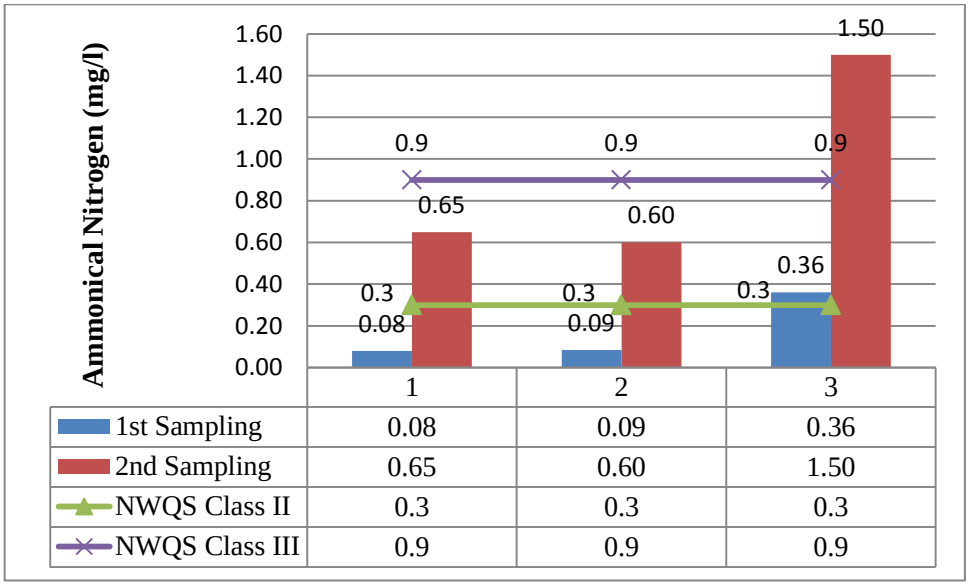


Fig 4.4.4: Ammoniacal Nitrogen Result

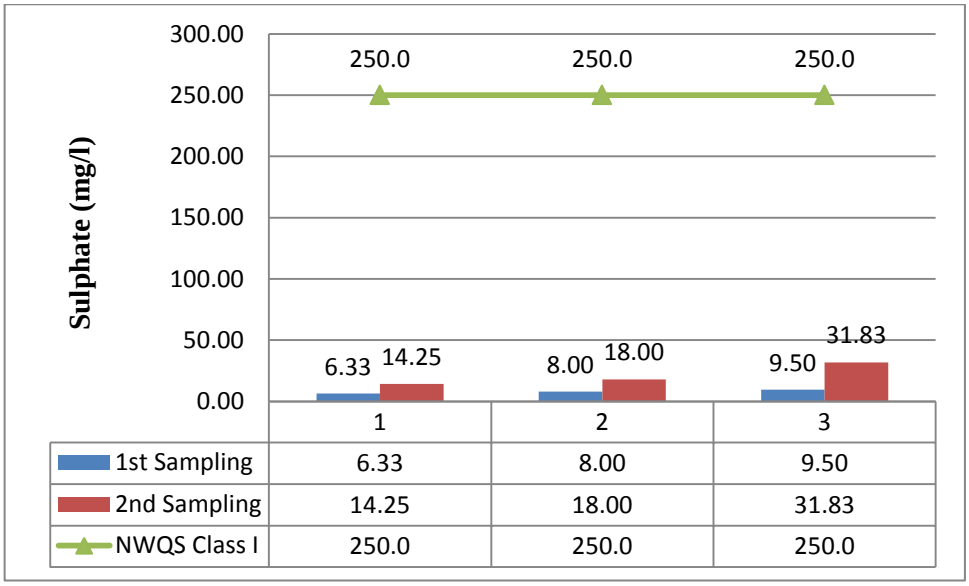
The result shows that on the first sampling, the value was very low compared to second sampling. The values for first sampling in three stations range from 0.08 mg/l to 0.36 mg/l. While on second sampling, the values range from 0.60 mg/l to 1.50 mg/l. It was clearly shown that on Station 3, it has highest value, either for 1st sampling or on 2nd sampling.

Second sampling has higher value compared to first sampling due to the weather factor. When the river is in high temperature, the ammioniacal nitrogen will increase. Ammoniacal nitrogen also depend on pH value. The lower the pH , the higher the AN.

Although ammonia is a nutrient that needs by living things, but when it has excessive it may be harmful to aquatic life. Sources of AN can be categorised into point source and non-point sources. Point sources are from industrial that produce ammonia effluents, or from sewage treatment plant, oil refineries and food processing. All this was related to human activities.

As the conclusion, AN on the Pekan river can be concluded as Class IIB for Station 1 and 2, and Class III on Station 3.

4.4.5 Sulphate



	1	2	3
1st Sampling	6.33	8.00	9.50
2nd Sampling	14.25	18.00	31.83
NWQS Class I	250.0	250.0	250.0

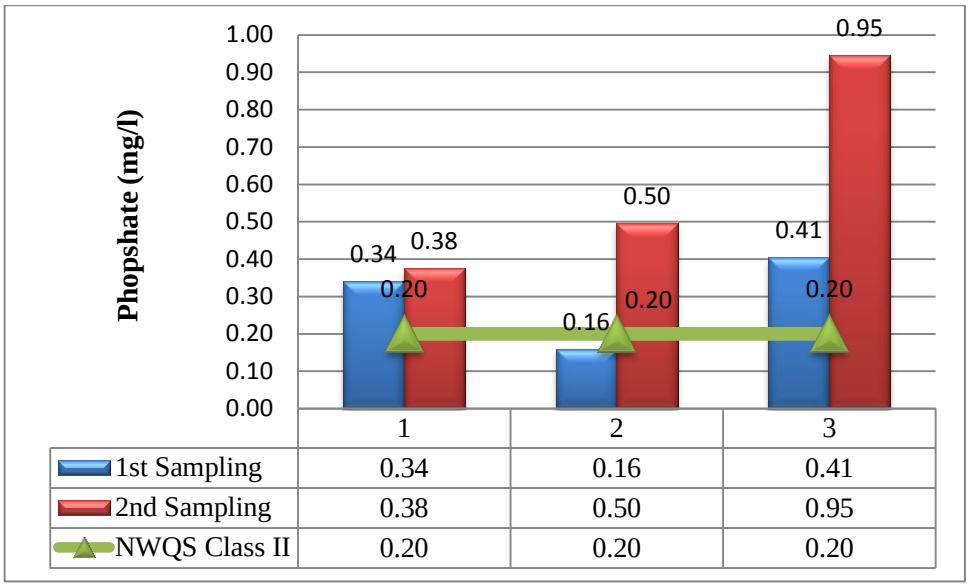
Fig 4.4.5: Sulphate Result

Fig 4.4.5 shows the result of sulphate in the Pekan river. First sampling was lower than second sampling. In every station, the value of sulphate increased. However, both of the sampling still not exceeded 250 mg/l, which means they were still on Class 1 according to NWQS.

Source of sulphate varies according to the natural process or from municipal waste, or industrial wastage. Naturally means, they were formed from the breakdown of leaves result that fall into the water. Municipal wastage or industrial wastage classified as point sources. Fertilizer runoff also can contribute to the sulphate presence.

Sulphate is quite soluble in the water. It was toxic to human and aquatic life such as fish. Sulphate occurs if the water is lack of oxygen or anaerobic. Sulphides formed from the runoff of acid mine from industrial, and then oxidized to form sulphate, which is less toxicity. Properties of sulphate were smelly like rotten egg. And because of that, it was avoided from both human and fish.

4.4.6 Phosphate



	1	2	3
1st Sampling	0.34	0.16	0.41
2nd Sampling	0.38	0.50	0.95
NWQS Class II	0.20	0.20	0.20

Fig 4.4.6: Phosphate Result

Figure shows the result of phosphate on the Pekan river. There were increase value on second sampling on each station compared to first sampling. this shows that phosphate value on second time sampling was much higher. On average, phosphate on first station was 0.36 mg/l, second station 0.33 mg/l and third station 0.65 mg/l. Overall, phosphate on the Pekan river was classified as Class II compared to NWQS.

Phosphate can exist in the water bodies from animals and human waste. They were also can be found in bedrock, industrial effluents, or runoff from fertilizer. On third station, which was lowest stream, there was effluent from petrol stations toilets near the river. This affects the water quality of the Pekan river.

4.4.7 Heavy Metals

Table 4.4.7.1: Heavy Metals Result

Elements	Station	1st Sampling	2nd Sampling	Mean
Cu	1	0.016	0	0.008
	2	0.013	0	0.007
	3	0.014	0	0.007
Pb	1	0.094	0	0.047
	2	0.171	0	0.086
	3	0.097	0	0.049
Fe	1	0.057	0.086	0.072
	2	0.286	0.074	0.180
	3	0.324	0.044	0.184

4.5 SUB INDEX VALUE OF WQI

After all the data analysis and comparison with National Water Quality Standard was done, below was the result of sub index value of Water Quality Index (WQI) in the Pekan river.

Table 4.5.1: Sub index value of WQI

St	DO	BOD	COD	NH_3-N	TSS	pH	SCORE	STATUS
1	0	57.8	65.7	84.5	80.7	88.2	57.5	Slightly Polluted
2	0	64.9	66.9	85.5	39.7	97.4	53.9	Slightly Polluted
3	0	59.0	53.3	60.5	61.5	97.5	50.4	Highly Polluted
						WQI	53.9	Slightly Polluted

On the upper stream, Station 1, there were just an ordinary stream flows without any disturbance of drainage into the river. That explained why on Station 1, there were always the lowest value of BOD,COD and turbidity and TSS. Station 1 can be classified as Class III according to Department of Environment (DOE) Water Quality Index Classification. Class III means for water supply usage, the river water need extensive water treatment before used, and in terms of fishery, it is on level III which classified as common.

On the middle stream or Station 2, there were located the petrol stations and vehicles workshops. Sadly, liquids wastage from vehicle workshop was directly drained in to the river. After the comparison with DOE-NWQS, it can be said that Station 2 was on Class III, same as on Station 1.

On the downstream or defined as Station 3, there were food courts and boats harbour near the sampling location. The river stream was obviously most cloudy and oily. The wastage from the food courts and spilled boat oil was directly drained into the river water without any proper wastage management. Station 3 also has the worst result of COD, BOD, turbidity and TSS due to its condition. Besides that, Station 3 also received water from stream on Station 1 and Station 2. This makes the situation of Station 3 worst. Station 3 was the most polluted among three stations with Class IV, irrigated.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

Basically, Pekan river was located at the middle of the Pekan city. The location of the river makes it exposed to the pollution either from industrial or human kind activities. Human activities along the river contributed to the water quality of the river. Many commercial activities held there.

According to the Malaysian Water Quality Index (DOE-WQI), Pekan river is classified as Class III with a mean of 53.9 which ranges from 50.4 to 57.5 (Table 4.5.1). Extensive treatment required for water supply use. The study shows that the pollution level was higher on lowest stream compare to upper stream, due to maximum water discharged from Station 3. It was clear that the main source of the pollutant was the anthropogenic activities. The variation of data shows that, station that has more human activities have high level of pollutant. Station 3 was near the food courts and harbour. The water was oilier compared to other stations.

Overall, from the water quality analysis done from February to June 2015, we can say that Pekan river is polluted and contaminated caused by human kind activities along the river and classified into Class III generally, when compared to INWQS.

5.2 RECOMMENDATIONS

To reduce the pollution level especially on river water, every parties and authorities should take into action to save the river. Everyone should have self-awareness about the importance of river water in daily life. Long term planning should be formulated from now on.

5.2.1 "Love Our Rivers" Campaign

Malaysian should be more aware about the importance of rivers water to our daily life. Water is important to human kind, animals and all living things on Earth. River is one of the sources of the water supply. If the sources of water supply were being contaminated, it will bring huge problem to the ecosystems. Campaign about 'loving our river' should be held more often, to inform the citizen about the importance of river water.

Besides, local authorities should establish committee members to monitor the cleanliness of the rivers, and immediately report to the authorities if there is anything problem with the rivers. The committee members should always aware about the condition of the river water and alert about any changes. By this, early precautions may be introduced to prevent bigger problem from happen. Malaysian should together carry this responsibility. Malaysians have the right to determine the condition of the rivers in future.

5.2.2 Role of Government

Government plays an important role in ensuring the rivers in Malaysia are in good condition and clean. They have the highest authority in determining the cleanliness of our rivers.

Department of Environment (DOE) is the most responsible authorities in managing the environmental issues in Malaysia. To improve the water quality on the

Pekan river, DID is suggested to focus on river water administration and monitoring the condition of the river. All the sources of pollutions should be terminated first.

In addition, the government must be strict in accordance with the laws of Malaysia said that the crackdown will be taken for those who violate and contaminate the river in Malaysia. A compound will also be charged for those who failed to follow the laws regarding rivers care such as throw the solids or liquid wastage into the river without proper management.

Besides that, government may establish the self-awareness into the Malaysians citizen since they are in primary school. Establish the attitude of loving the rivers and environment since they are primary schools may have the biggest impact to our future rivers. This is because, at young age, they will easily absorb new things and knowledge. If from the start, we implement the ‘environmental lover’ attitude, it can be lasting until their gold age.

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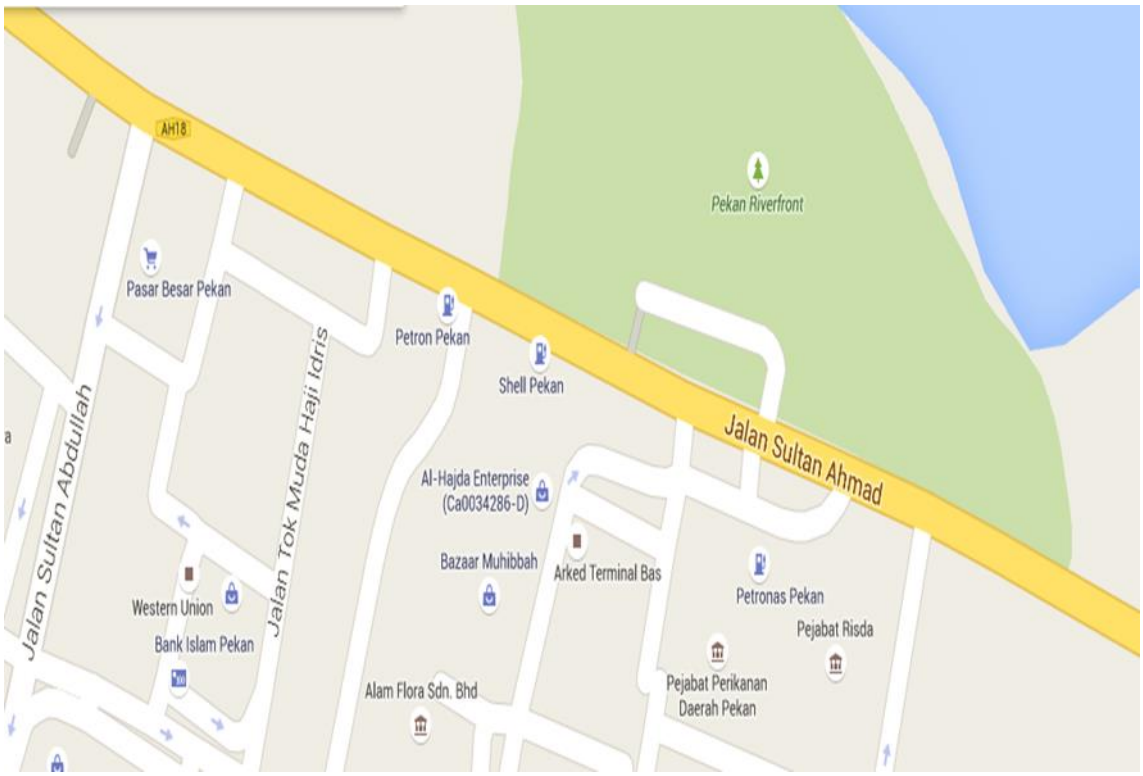
APPENDIX A

MAP OF PAHANG RIVER

APPENDIX B

MAP OF PEKAN RIVER

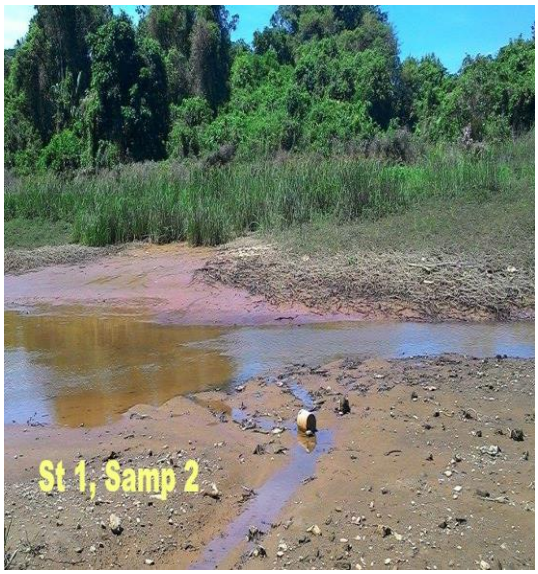


APPENDIX C

OVERVIEW OF SITE

APPENDIX D

SITE SAMPLING

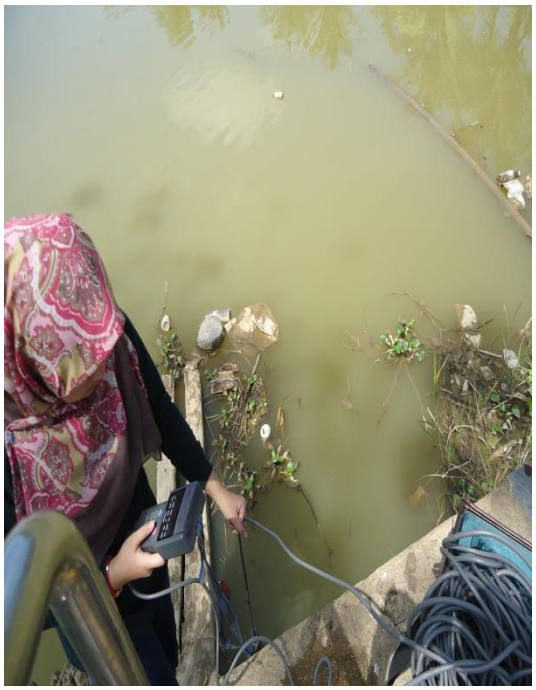



St 3, Samp 1


St 3, Samp 2

APPENDIX E

IN-SITU TESTS



APPENDIX F

EX-SITU TESTS

Fig F1: BOD Test

Fig F2: TSS Test

Fig F3: Ammoniacal Nitrogen Test

Fig F4: Heavy Metals test

Fig F5: COD Test

Fig F6: Sulphate Test

APPENDIX G

DOE-WQI CLASS

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	<2.5	25 - 50	50 - 150	30 - 50	>300
WQI	>92.7	76.5 - 92.7	51.9 - 76.5	31 - 51.9	<31.0

APPENDIX H

SUB-INDEX DOE-WQI CALCULATION

Parameter	Value	Sub Index Calculation
COD	$X \leq 20$	SICOD = -1.33x + 99.1
	$X > 20$	SICOD = 103* exp(-0.0157x) - 0.04x
DO	$X \leq 8$	SIDO = 0
	$X \leq 92$	SIDO = 100
	$8 < X < 92$	SIDO = $-0.395 + 0.030x^2 - 0.00020x^3$
BOD	$X \leq 5$	SIDOD = 100.4 - 4.23x
	$X > 5$	SIDOD = 108* exp(-0.055x) - 0.1x
NH_3-N	$X \leq 0.3$	SIAN = 100.5 - 105x
	$0.3 < X < 4$	SIAN = 94* exp(-0.573x) - 5* I x - 2 I
	$X \geq 4$	SIAN = 0
SS	$X \leq 100$	SISS = 97.5* exp(-0.00676x) + 0.05x
	$100 < X < 1000$	SISS = 71* exp(-0.0061x) + 0.015x
	$X \geq 1000$	SISS = 0
pH	$X < 5.5$	SlpH = 17.02 - 17.2x + 5.02x2
	$5.5 < X < 7$	SlpH = -242 + 95.5x - 6.67x2
	$7 \leq X < 8.75$	SlpH = -181 + 82.4x - 6.05x2
	$x \geq 8.75$	SlpH = 536 - 77.0x + 2.76x2

APPENDIX I

SUB INDEX WQI VALUE

St	DO	BOD	COD	NH_3-N	TSS	pH	SCORE	STATUS
1	0	57.8	65.7	84.5	80.7	88.2	57.5	Slightly Polluted
2	0	64.9	66.9	85.5	39.7	97.4	53.9	Slightly Polluted
3	0	59.0	53.3	60.5	61.5	97.5	50.4	Highly Polluted
WQI							53.9	Slightly Polluted

APPENDIX J

WATER QUALITY INDEX (WQI) CLASSES

WQI	CLASS	USES
< 92.7	I	• Conservation of natural environment. • Water Supply I - Practically no treatment necessary. • Fishery I - Very sensitive aquatic species.
76.5 – 92.7	II	• Water Supply II - Conventional treatment. • Fishery II - Sensitive aquatic species. • Recreational use body contact
51.9 – 76.5	III	• Water Supply III - Extensive treatment required. • Fishery III - Common, of economic value and tolerant species; livestock drinking.
31.0 – 51.9	IV	• Irrigation
<31.0	V	• None of the above

ADVERSE EFFECT OF ANTHROPOGENIC ACTIVITIES ON WATER QUALITY OF THE PEKAN RIVER

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