ASSESSMENT OF PHYSICO-CHEMICAL QUALITY OF NWORIE RIVER, IN OWERRI METROPOLIS

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CERTIFICATION

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DEDICATION

I dedicate this work to the blessed memory of my sweet caring mother late Mrs. Anne. E. Nwere whose motherly advice has led me to this stage, I say may her gentle soul rest in the blossom of the Lord Amen.

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ABSTRACT

Pollution of rivers, had become a major problem facing our society today. This often occurs as a result of waste washed into Rivers as in the case with Nworie River in Owerri metropolis. In order to assess the water quality of Nworie River, water samples were collected at three locations namely point A (upstream) serves as control, point B (midstream) and point C(downstream). The samples were properly analyzed with focus on some physical and chemical parameters.

The result of the analysis showed that colour ranged from 5-10pt/Co, turbidity 0-1{NTU}, Water Temperature 23-26^{o}C, pH 5.20-5.75, electrical conductivity 58.0-.77(µS), sulphate 0.061-0.076mg/Lotal hardness 20.30-52.00, total dissolved solid 38-50mg\l, t, t otal suspended solid 4-19.00, biological oxygen demand 0.4-0.7 mg/L, dissolved oxygen 5.2-6.4mg/L, chloride 13.00-16.00mg/L, Nitrate 0.061-.0.076mg/L, phosphate 0.014-.0.053, iron, Nickel 0.10-0.99, lead 0.060-0.102 mg/L,. At the end samples were compared with Federal ministry of Environment and World Health Organization standards so as to ascertain which of this parameters are above permissible level. It was observed that some of the parameters did not exceed the recommended limit, with exception in pH which indicates that the river is acidic. Making the river very contaminated. Thus, further work on the biological profile of the needs to be done.

CHAPTER ONE

INTRODUCTION

1.1 BACKGROUND OF STUDY

Water is essential for survival of any form of life on an average, a human being consumes about 2 liters of water daily. About 80% of the earth surface is covered by water out of the estimated 1,011 million km^3 of the total water present on earth, on $33km^3$ of water is available for drinking, agriculture, domestic and industrial consumption (Dara,1993). The word water distribution in volume $10^{12}m^3$ are as fresh water lakes 125 (0.009%), saline lake and inland sea 104 (0.008%), rivers 125 (0.001%), soil moisture 67 (0.005%), groundwater above depth of 4000m and 350 (0.61%), ice caps and glacier 29,200 (2.14%), total land area 37,860 (2.8%), Atmosphere 13 (0.001%) and oceans 1,320,000 (97.3%) (Khitoliya, 2004)

Water can be classified into surface and subsurface water, surface water includes water found on the surface, they are divided into estuaries water, including the ocean and the inland surface water covering creeks, lakes, dam etc. surface water which is accessible represent only about 0.02% of the total and

distributed here and around the world (Ademoroti, 1996) subsurface water refers to the water beneath the earth surface which occupies part of the interstices in a geological layer. It can also be defined as the water within zone of saturation (Nwaogazie, 1998). Underground water is naturally replenished through rain water as recharge and occasional through surface water and ground water interaction (via rivers, lakes, etc).

Man has used water for host of sanitary purpose including the disposal of waste from domestic and commercial activities Serious changes in water quality have resulted depending upon the nature and extent of the water supply, the number and kinds of users, the geographic placement of water user along the ways and degree of pollution control (Akhionbare, 2009). Also, water pollution may be defined as the presence of impurities in water in such a quality and of such natural as to impair the use of water for a stated purpose. The pollution of water occurs where there is an additional undesirable quality of water. Meanwhile, water that is safe for drinking by man and animal that support a wholesome of marine life, that is fine irrigation purpose and recreation can be said of a good quality (Osibanjo, 1992).

Degradation of surface water resources is a serious problem, pollution of surface water results find their way into water exceeding the natural ability of that water body to remove the undesirable material or dilute it to harmless level (Bolkin et al, 1997). Surface water is subjected to pollution mainly by authropogenic factors contributing to pollution of water are agricultural waste, industrial waste, hospital waste, domestic waste and natural waste. Also leachate from dumpsite and increased industrialization and urbanization has led to a wide scale of contamination of Nigerian's surface water discharge and excessive usage of fertilizer and pesticides (Osibanjo et al, 1981). Food items, containers, municipally waste are dumped and are often carried from one place to another by rodent, flies, rats, vultures, kites and millipedes etc. most of these organisms pitch on this dumped sites and migrate to a housing areas or commercial home. The end point effect is disease outbreaks and etiological (Orime, 1998).

1.2 STATEMENT OF THE PROBLEM

Water quality problem has increasingly attracted attention from authorities and communities throughout the world and more especially in the developing countries. This problem can be attributed to certain consequences of both economic development and increase in population density { Nnaji et al, 2010} Nworie River being one of the major surface waters in Imo State is not excepted from this problem.

Various land use activities such as animal grazing, livestock rearing, farming, residential and industrial activities all pose a serious threat to the river quality. Also there is discharge of all manner of toxic chemicals, clinical waste, organic waste and nutrient into Nworie river by industries, hospitals, and educational institutions, thereby increasing the concentration of pollutants , degradation of river quality and more eutrophication incident. This leads to the death aquatic organism, water borne disease such typhold fever, dysentery, cholera in human. The problem this research addresses is the pollution potential of Nworie River as a result of man's activities on the water quality.

1.3 AIM AND OBJECTIVES OF STUDY

This study aims at assessing the quality of Nworie River through determining the physico-chemical pollution parameter present in the water.

The following are the objectives:

- To determine the physical and chemical characteristics of N Nworie River,
- To determine the concentrations and values of these pollution parameter as listed in the scope of study,
- To compare the results of the physico-chemical with World Health Organization [WHO] and Federal Ministry of Environment {FME} established standards for drinking water,
- To inform the general public about the state of Nworie River,
- To provide and make recommendations against indiscriminate dumping or disposal of waste beside or near Nworie River.

1.4 RELEVANCE OF THE STUDY

The study will serve as a means of enlightening the people on the river quality especially for domestic purposes. This study will provide a framework for establishing acceptable guidelines and criteria for monitoring maximum standard for Nworie River. Also given the hazard posed to human and the aquatic environment through waste material washed into Nworie River from the nearby dump site.

And, the study will then provide useful information that will help the government in the formulation and enactment of laws that will protect the health of people within and around the area.

1.5 SCOPE OF STUDY

The study would investigate the following physicochemical pollution indicators as follows:

- Temperature,
- Colour,
- Turbidity,
- Electrical conductivity,
- Total dissolved solid (TDS),

- Total suspended solid (TSS),
- pH,
- Nitrate,
- Sulphate,
- Phosphate,
- Chloride,
- Biological oxygen demand (BOD),
- Dissolved oxygen (DO),
- Lead,
- Cadmium,
- Iron and
- Nickel,

CHAPTER TWO

LITERATURE REVIEW

2.1 WATER QUALITY ASSESSMENT

Water quality assessment involves the estimation/evauation of the quality of water with respect to all active and potential factors that may affect it positively or negatively, such factors include sanitation, human activities, socio-cultural habit, water use etc {Akionbare,2009}.

Environmental assessment uses environmental analysis as tool. Environmental quality analysis involves the determination of various characteristics that make up the environment such as physical, chemical, biological, radiological etc.{ Akionbare, 2009}.

2.2 CONCEPT OF WASTE

Waste is everyone's business. We all produce unwanted products and residues in nearly everything we do. Waste is the product of human society. Some of the definitions of the word waste is clouded with intellectual vagueness. Some of the definitions of waste are as follow: Okereke (2000) defined waste as undesirable substance which the holder or generator wishes

or is required to disposed off. Waste is also defined as useless and unwanted materials (Eke, 1994). Akajobi in 1998 defined waste as unwanted and discarded materials that arise from every activities of life. According to oxford advanced learners dictionary defined waste as material that is no longer needed and thrown away. For instance, house hold/industrial waste, toxic/radioactive waste. Etc.

Despite all these definitions, waste is defined as all residue in solid, liquid, or gaseous form resulting from process of production transformation and consumption, all material objects, substance and generally all things abandoned by owner or holder which may be recovered, stored, recycled and reused. Accumulation of waste materials leads to pollution of environmental resources such as air, land, water etc. Our waste becomes more and more complex everyday in the whole world (Dara, 1993). Waste may be in solid, liquid or gaseous form (Okereke, 2000).

2.3 FORM OF WASTE

Waste occurs in three forms namely: solid, liquid, and gaseous forms.

2.3.1 Liquid form

Liquid wastes are unwanted liquid arising from human activities or industrial activities. Liquid waste is mainly referred to as effluence. (Dara, 1993) liquid waste is generated from the following activities industrial, agricultural domestic, residential, sewage, hospital, etc (Dara, 1993).

Water pollution can be broadly classified into the following five categories:

- Organic pollution;
- Inorganic pollution;
- Suspended solid and sediment;
- Radioactive material; and
- Heat

2.3.2 Gaseous waste

Gaseous waste is in gaseous form arising from domestic or industrial activities. Excessive release of gaseous pollution into the atmosphere by anthropogenic source disturbs the dynamic equilibrium in the atmosphere and thereby affects man and his environment (Dara, 1993). Source of gaseous pollutant includes

industrial activities, domestic or household agricultural etc (Eke, 1993)

2.3.3 Solid waste

Solid waste refers to unwanted solid or semi solid material arising from human activities (Okereke, 2000).

Solid waste can also be defined as any unwanted or discarded solid material from residential, commercial, industrial mining, agricultural activities that causes environmental problem (Dara, 1993).

They are normally generated and discarded as useless at point of disposal. Solid wastes are categorized as commercial, residential, sanitation, trade, industrial, institution waste (Dara, 1993).

2.4 SOURCES OF SOLID WASTE

Solid waste is generated by different sources. These sources are grouped into two broad classes namely.

- Natural sources; and
- Anthropogenic sources.

2.4.1 Natural sources

This waste arises from natural factors. They include dead organic matter arising from plants and animals. Dead plants, leaves, branches etc fall into the surface water and decay in them (Ademoroti, 1996).

They tend to dissolved in water as they decay. The decaying plants material gives rise to fungal, micro-organism while the decaying animal yields bacterial (Ademoroti, 1996).

2.4.2 Anthropogenic sources

They are usually man made or artificial sources of solid waste. They are as follows.

2.4.2 1 Agricultural sources

Agricultural wastes are generated crop or animal product (Okereke, 2000). Agriculture waste includes waste arising from farms, feedlots and livestock yards. The waste include paddy hust, baggage from sugarcane, tobacco, corn residue, slaughter house waste, manure etc (Dara, 1993).

The relevant human agricultural activities in surface water are human being fermenting of cassava tubers for foods and

washing of melon. This activities contributes to the pollution of surface water (Ikom, 1998)

Agricultural waste can also includes material like fertilizer, pesticides, herbicides and manure that are wasted off from land surface during rainfall into the surface water. Pesticides have been demonstrated causing serious problem. (Odeyemi, 1999).

2.4.2.2 Hospital source

Hospital or medical waste is generated during diagnosis treatment or immunization of human being or animal. Medical waste can also be generated during research activities in medicine or veterinary or in the production or testing of clinical things. It may include anatomical waste, culture, and discarded medicine chemical waste, and disposable like needles and syringes, others are bandages, swab cloth soiled with blood etc (Okereke, 2000).

Medical waste is highly infectious and can be a serious threat to human health if not managed in a discriminate manner (Dara, 1993).

Hospital waste is a special waste requiring separate management. In addition, they are disease causing waste. The

are mainly pathogenic microorganism which may either enter the water along with sewage and other waste, causing tremendous damage to public health (Dara, 1993).

2.4.2.3 Domestic sources

Domestic waste is generated from household mainly from domestic activities example are heterogeneous plastic, can, food left over bottle etc.

Domestic waste result from peoples day to day activities such as bathing, body excretion, food preparation, recreational lavatories etc from public and private buildings (George, et al, 1979). The dumping of human waste into the surface water may add intestinal bacteria along with other pathogens to the water. The coliform organism is the most widely used indicator of fugal contamination of water.

2.4.2.4 Municipal sources

Municipal waste results from consumption of goods and sources. They include garbage and rubbish from household offices, hotel, market etc. also the street refuse such as street

sweeping dirt leaves content of litter receptacles etc. (Dara, 1993).

2.4.2.5 Commercial sources

Commercial waste are generated from shop, restaurants, market office buildings, hotels, print shops etc. this waste includes paper, cardboard plastic, wood, food waste, glass, metal etc (Mackenzie etal, 2009).

Commercial solid waste is almost similar to residential solid waste in characteristics except that the former contais more of bottles while the later contains more of domestic food waste (Dara, 1993).

2.4.2.6 Institution sources

Institutiond waste arises from school, hospital, governmental centers etc (Mackenzie et al, 2004). Example of this waste includes the following: glass, food waste, plastic cardboard, special waste, hazardous waste etc (Mackenzie et al, 2004). Institutiond waste also refers to waste from Universities, Polytechnics, Banks etc.

2.4.2.7 Industrial sources

Industrial wastes are generated from industrial activities such as instruction, fabrication, light and heavy manufacturing, refineries, chemical plants, power plants, demolition etc (Mackenzie, 2004). The quality and character of industrial waste water is highly varied depending on the management of its water usage and degree of treatment of the waste water received before it is discharged (George, 1991).

Industrial waste is grouped based on non process waste such as office and cafeteria waste packing waste etc. process waste which depends upon the type of the product being manufactured such as tannery, weaving and dying waste food processing etc (Dara, 1993). The untreated waste from industries is discharged into the surface water thus leading to high biochemical oxygen content of the surface water. There will also be trace of heavy metals solvent, and salt etc in surface water many of these are toxic when they occur in high concentration. (Ademoroh, 1996).

2.4.2.8 Construction sources

Construction waste is quite heterogeneous in character and may be composed of discarded building materials which are wasted during the construction of new structure and facilities. They may consist of wood, steel, bricks, concrete and other construction materials which are wasted during the demolition of existing structure and facilities (Ahionbare, 2009). Moreso, these wastes are non-degradable and except for the wood waste will exhibit very little decomposition with time. They are often quite used as solid fill (Akhionbare, 2009).

Sources of this waste include new construction sites, road repair, renovation sites, and demolition of building, etc.

Table 2.1: Sources and Types of Solid Waste

SOURCES	TYPICAL WASTE GENERATORS	TYPES OF SOLID WASTE
Residential	Single and multi family dwelling	Food waste, paper cardboard, plastics, yard ward, glass metal ashes special waste.
Industries	Light and heavy manufacturing fabrication, construction sites, power/chemical plants.	House keeping waste, packaging, food waste, construction, demolition material, hazardous waste, ashes special waste.
Commercial	Store, hotel, restaurant market , offices building etc.	Paper, cardboard, plastic, wood, food waste glass, hazardon waste.
Institution	School, hospitals school etc.	Same as commercial.
Construction	New construction sites, road repaired, renovation, demolition of building	Wood, steel, concrete, dirt. Etc.
Municipal	Street cleaning, land scalping, parks, beaches other recreational areas etc.	Street sweeping, landscape and tree trimming, recreation area, sludge's.
Agriculture	Crop, orchard, vineyard, daries, feedlot, farms.	Spoiled food, waste, agricultural waste, hazardous waste. E.g. pesticides.

(Source: Nkwocha, 2002)

2.5 SOLID WASTE DUMPSITE

Dumpsites are area in which waste are simply deposited and left to rot or decay (Dara, 1993), Meanwhile, solid waste dumpsite as any piece of land where solid waste material is dump. As town and cities developed, people began to live in densely populated area and the production of waste becomes a health problem. In response to this threat, town and cities designated dumping site areas for solid waste usually on the out

skirts of the town. All forms of solid waste were dumped including industrial, medical and household waste (Tchobanrglous et al, 1993)

Dumps in most towns were left uncovered and there were no attempts to treat the waste. Fire sometimes started spontaneously in these dump, rodents and insect often became severe problem (Tehobanoglous et al 1993). In open dumps, rain water moves through the refuse and absorbs any organic or inorganic compound that is in refuse. This liquid (leach ate) enter the ground water and surface water posing risk to environmental risk and Kerman health for the communities that depends on for drinking (EPA, 1991).

2.6 EFFECT OF WASTE ON SURFACE WATER

The harmfulness of these waste to quality of the water into which is largely dependent upon the premises and activities from which it originated in case of industrial premises certain waste are likely to be toxic to the aquatic environment (William et al, 2001). According to Melinda 1981, industrial and domestic waste could add large amount of organic or inorganic substance into aquatic system that produce turbidity. It is has been reported

that small amount suspended matter on sparing site may affect the life history of fishes, high concentration of suspended solid reduces transparency and photosynthesis. Thus clog the gills of fishes. It also lowers the temperature of the surface water (Egborge, 1981).

Organic waste under the influence of bacterial action depletes the dissolved oxygen by consuming it in biochemical oxidation reaction. This may suffocate the fish and pother aquatic animal which require the presence of an appreciable concentration of dissolved oxygen (Pandey et al, 1989). High level of nutrient in water can cause tiny floating plant to boom which can kill fish and invertebrate. Boom can also produce toxic which make water unsafe for swimming and food dangerous to eat (Ross et al, 1962).

With mild pollution, fish may acquire a flavor that renders their flesh unfit for use as food where as with more severe contamination the fish sicken or die. The latter may also be result of the presence of substance that are not in themselves toxic but cause as phyxiation by injury the gills, suspended solid

such as silt and coal have been particularly trouble some in this respect (Pandly, 1989)

And in a serious case the effect of removal of oxygen asphyxiate fish and other aquatic creature living in the water course and in a longer term to cause the water to become an aerobic (Dug gal et al, 1996)

2.7 EUTHROPHICATION

Euthrophication is the enrichment of a water body by nutrient. The word euthrophucation originated from two Greek word E.U. meaning good or well and trophies meaning food (Dara, 1993). The enrichment of a water body with respect to nutrient may take place because of natural source example remains and anthropogenic source example man made source like domestic or agricultural process (Dara, 1993). Runoff from agricultural land supply plant nutrient which may stimulate growth of algal and other aquatic weeds in the receiving water body. The unwanted plant growth result in the degradation of value of the water body intended for recreational and other uses (Dara, 1993). Euthropucation usually recur when fresh water

bodies are made to serve as disposal outlet for community waste such rivers are covered by plant growth (Akionbare, 2009).

2.8 LEACHATE IN SURFACE WATER.

Leachates are liquid that passes through the landfill, extracts, dissolved and suspended matter from the waste materials (Mackenzie et al, 2004). External sources such as rainfall surface drainage, groundwater and the liquid in and produced from the decomposition of waste.

Leachate from animal excreta, decaying bodies of plants and animal and the decay of large quantities of organic matter as in swaps or deep pond also introduces appreciable quantities of micro organism (Pandey et al, 1980). Some solid material is dissolved in water percolating through the fill (Mankenzie et al, 2004).

2.9 WATER QUALITY

Water quality is a widely used expression which has a broad spectrum of meaning. However water quality can be regarded as an assessment of its suitability for a specific use (Kiely, 1998). The quality of water is assessed in terms of its

physical, chemical and biological characteristics and its intended uses (Linsely and Tranzini 1988).

Pollution and water quality degradation thus interface with important and legitimate uses at scales from local regional to international level (Kiely, 1998) water quality involves two sets of standards namely:

- The quality of raw water
- The quality of the treated portable water

2.9.1 Water quality standard

The term standard may be applied to any definite rule, principle or measure established by authority (Chapman, 1992). Water quality standard are use to prevent misuse of water resource for industrial gain.

Agencies in charge of water quality standard in Nigeria include:

- Federal environmental protection agency.
- State environmental protection agency.
- Federal ministry of health.

Other international agency

- Environmental protection agency

- World health organization.
- United state environmental agency.

Table 2.2 Federal Environmental Protection Agencies (1992)

WATER QUALITY PARAMETERS	MAXIMUM ALLOWABLE LIMIT
PHYSICO-CHEMICAL	
Appearance	clear
Color (Pt/co scale)	15
Turbidity (NTU)	50
Temperature (^oC)	<15
Ph	6.5-8.5
Electrical conductivity (Ps)	100
Acidity as $CaCO_3$ (mg/1)	10-40
Alkalinity as $CaCO_3$ (mg/1)	10-40
Sulphate (mg/1)	250
Total hardness $CaCO_3$ (mg/1)	250
Calcium hardness as $CaCO_3$ (mg/1)	200
Magnesium hardness as $CaCO_3$ (mg/1)	200
Chloride (mg/1)	600
Nitrate (mg/1)	40
Chemical oxygen demand (mg/1)	40
Total iron (mg/1)	0.3
Total solids (mg/1)	300
Total dissolved solids (mg/1)	250
Total suspended solids (mg/1)	50
Manganese (mg/1)	0.1
BACTERIOLOGICAL	
Total microbial load per ml	5-10
Total coli form count (MPN/100ml	0-2
Escherichia coli count (MPN/100ml	0

2.10 WATER QUALITY PARAMETERS

Impurities in water can result from the following soil minerals and rock, atmosphere decomposition of organic matter living organism, municipal and industrial sources and other

human activities (Isaac, 1965). It is generally desirable that water must be fit for human consumption and palatable. It should be suitable for uses other than drinking for example sufficiently soft for washing (Ubong et al, 2001). Although all water is normally considered as water, all natural water contain varying amount of other materials in concentration ranging from a few milligram to 35,000mg (Tebutt, 1977). It determine water quality, its often necessary to measure several different properties by carrying out physical, chemical and biological analysis (Tebutt, 1977)

2.10.1 Physical parameter.

2.10.1.1 Colour

Water sometimes contains considerable colour resulting from certain types of dissolved and colloidal organic matter Clinsley and Franzini 1988) reached from soil or decaying vegetations. True colour in water results from contact of water with decomposing organic matter leaves, wood etc. Suspended sediment such as red clay alter water colour but this type is colour is termed apparent colour.

2.10.1.2 Temperature

Temperature is a measure of how cool or warm the water is expressed in degree Celsius (^{o}C). Temperature is a critical water quality parameter because it directly influences the amount of dissolved oxygen that is available to aquatic organism. Temperature has pronounces effect on oxygen uptake because metabolic activities increase significantly at higher temperature (Keller et al, 1995).

2.10.1.3 Turbidity

The high the turbidity the greater the absorption of light rays from a source of light in the opposite side of the sample and less that is transmitted in straight lines through the samples (Duggal, 1996).

Turbidity is caused by either colloidal or finely divided suspended matter which settled slowly and with difficulty (Hammer, 1977). Turbidity is not necessarily harmful to fish but it reduces the intensity of sunlight to the receiving water body thus reduces the photosynthesis reaction of the stream (Metcalf and Eddy, 2004).

Accumulation of turbidity causing particle in porous stream bed result sediment deposit that can adversely affect the flora and fanna of the river (hammer, 1977).

2.10.1.4 Electrical conductivity

Conductivity is a measure of the ability of water to conduct an electric current and it is used to approximate salacity and total quantity of dissolved salt present and for dilute solution.

$$K = \frac{\text{Conductivity, cus/cm.}}{\text{TDS (mg/c).}}$$

2.10.1.5 Total dissolved solid

Total dissolved solid is a measure of the amount of particular solid that are in solution. This is an indicator of non-point source pollution problem associated with various land use practice.

2.10.2. Chemical parameters

2.10.2.1. pH

This is a measure of acidic or basic nature of water and is defined as log of reciprocates of hydrogen ion concentration in moles/liter (Linsley et al, 1988). PH of neutral water is 7, less

than 7 is acidic and greater than 7 alkaline (Sawyer and McCarty, 1978).

2.10.2.2 Sulphate

Sulphate appears naturally in water. However industrial effluents frequently contribute to the amount of sulphate by way of pyrite oxidation and use of sulphuric acid. Sulphate may be beneficial or detrimental in water used for domestic and manufacturing purpose.

2.10.2.3 Biological oxygen demand

Biological oxygen demand (BOD) is defined as the amount of oxygen that is consumed by bacteria “feeding” on decomposable organic matter under aerobic conditions. Measure of BOD in lakes, river and estuaries are used to predict potential negative waste source may contribute on natural waters (Sayers and McCarty, 1978).

2.10.2.3 Dissolved oxygen (DO).

This is important chemical parameter in environmental water quality assessment. Its presence is required to maintain

the high forms of biological life. Clean surface water is normally saturated with DO but can be rapidly exhausted by the oxygen demand of organic waste. (Ubong and Gobo, 2001).

2.10.2.4 Heavy metals

Heavy metals are elements having atomic weight between 63.54g and 200.59g and a specific gravity greater than 4.0ml Living organisms require trace amount of heavy metal for example, cobalt, copper, iron, zinc etc, though excess of these essential metals can be detrimental to these organism, in surface water (Karen and Dan, 2001). Heavy metal may be found in oxides, silicates, sulphide absorbed to clay, Silica or organic matter. The soluble form of their existence is in iron or unionized (Karen and Dan, 2001).

Harold and Jerry, 1976 reported that clean up of crude oil refining operation increased the heavy metal concentration discharged into surface water.

CHAPTER THREE

RESEARCH METHODOLOGY

3.1 RESEARCH DESIGN

The research study tries to carryout analysis on the assessment of physicochemical quality of Nworie River. It is designed that sampling would be carried out on three points only. Sampling point A {SPA} would be at the upstream {isi mmiri} and would serve as a control. Sampling point B {SPB} will be the midstream and sampling point C {SPC} will be the downstream.

3.2 NATURE OF DATA

This entails the secondary and primary data used in this work.

3.2.1 Secondary data

Secondary data used in the research include materials and information from text book, journals, handbooks, electronic media, literature from other peoples work etc.

3.2.2 Primary data

Primary data includes data obtained from the field, they include results of analyses of the samples and observations made during sampling.

3.3 DESCRIPTION OF STUDY AREA

3.3.1 Site location

The river under study is Nworie River in Owerri metropolis of Imo State of Nigeria. Nworie River is a first order stream that runs about a 5km course across Owerri metropolis in Imo State, Nigeria before emptying into another river, the Otamiri River {Acholonu et al, 2008} The area falls between the latitude 5^{o} 25^{o}N-5^{0} 30^{0}N and longitude 7^{0}E-7^{0} 10^{0} E {Atlas of Imo State}.

3.4 VEGETATION

The area lies within the tropical rain forest but the vegetation is more of Sudan savannah generally devoid of thick forest but consists of shrubs, tall grasses, and a few trees (Uma et al, 1984).

3.4.1 Climate

The study area has the sub eruptional type of climate. It is characterized by two distinct seasons that runs from mid march to October with a short dry season in August break. The dry season is from November to March.

This is influenced by the north east trade wind which moves over the region during the period. The temperature is generally high with a mean monthly temperature about 27^{o}c. the annual rainfall is between 200 and 2250mm while the relative humidity stands at 80-90^{o} during dry season {Nnaji and Duru 2008}

3.4.2 Land use

Agriculture is the principal land use activity in the area and the crops grown include yam, cassava, maize, okra, cocoyam etc. Also fish farming is another activity carried out in the area. Agricultural activities of the area are mainly subsistence. Agriculture due to poor mechanized method (Onyeagocha, 1981) settlement And industries also contributes to land use activities in the area.

3.4.3 Population

Owerri has experienced increased population in agriculture and industrial growth since its creation in 1976. This is attested by the 1963 census population of 102,800, 1976 of 146,000, 1991 of 234,931 and a 2006 population of 3 million people.

3.5 DATA COLLECTION METHODS

3.5.1 Sampling

The objective of sampling is to collect a portion of material small enough in volume to be transported conveniently and handed in the laboratory while still accurately representing the material being sampled. This supposed that the relative proportion or concentration of all pertinent components would be the same in the sampled and that the sample would be handled in such a way that no significant changes in composition will occur before the rest are made.

3.5.2 Sampling period

This study was conducted in December, 2010 on Nworie River. The sample was collected on 9th December,2010.

3.4.2 Sampling location

The three sampling points were carefully selected along the river. These sampling sites were denoted as "A", "B" and "C"

SITE A = upstream { isi mmiri Egbeada, the source of Nworie river}

SITE B = midstream { fuason industries Owerri, 420m to site A}

SITE C = downstream {East\West bridge Nekede, 400m from site B}

3.5.3 Sampling method

Water samples were collected into a 4 liter container for the analysis of the physical and chemical parameter. Also another water sample was collected for dissolved oxygen with a sterilized bottle at the River depth of 1m below the water surface for dissolved oxygen.

It was ensured that no air was trapped in the bottle, by tilting the bottle and inserting the stopper with a quick thrust

3.5.4 Sampling preservation

This entails maintaining the samples wholesomeness preservation of sample is usually different because almost all preservation method interferes with some of the test storage at low temperature 4^{oC} the best way to preserve most samples until the next day. Immediate analysis is ideal. The sample collected was preserved in a low temperature of 4^{oC} using ice chest.

3.5.5 Environmental conditions

During the site visit the following observations were made.

SITE A:

Atmospheric Temperature: 23°C

Water Temperature: 26°C

Time of collection: 12.13pm

Date of collection: 09/12/10

River flow rate: 0.6m/s {The flow rate was obtain using technique of measuring the time it takes for a pieces of paper to cross a

measured distance and then dividing the distance measured by the time taken. The flow rate was expressed in meter per second}

Depth of collection: 20cm

Description of the site A:

At the time of sampling the following observations were made, the colour of the water was clear, water current was strong, domestic activities like bathing and washing were going on. Leaves were seen floating at the station.

SITE B:

Atmospheric Temperature: 22°C

Water Temperature: 25°C

Time of collection: 2.03pm

Date of collection: 09/12/10

River flow rate: 1.0m/s {The flow rate was obtain using distance-time measurements}

Depth of collection: 20cm

Description of the site B:

At point B, the colour was clear, the water current was stronger than site A as it comes out from the fuason bridge , the intensity

of domestic activity was high, mainly that of bathing and Landry activity at time of sampling.

SITE C:

Atmospheric Temperature: 21°C

Water Temperature: 25°C

Time of collection: 2.03pm

Date of collection: 09/12/10

River flow rate: 1.2m/s {The flow rate was obtain using distance-time measurements}

Depth of collection: 20 cm

Description of the site C:

At sampling point C. The colour of the water was clear and its smell was satisfactory. The water current was high as water comes out from the bridge, Other domestic activities such as washing, bathing were going on.

3.6 INSTRUMENTATION

3.6.1 Field material

Material and equipment listed below were used at point of sample collection and sampling of the area:

- Mercury thermometer with calibration 0ºC-100ºC
- An ice chest
- A pair of glove
- 2.5 liter plastic cans {three pieces}
- Sterilized bottle for BOD analysis
- Masking tape
- A giant cooler
- Aluminum foil
- pen
- field book

3.6.2 Laboratory equipment

- Portable data logging spectrophotometer MODEL NACE,DR 2010
- pH meter model PHS-25
- Lab Tech Signal Turbidity Meter.
- Nessleriser comparator
- Conductivity Bridge model MC
- Weighing balance
- Incubator

- Oven
- Magnetic stirrer

3.6.3 Laboratory material

- 250ml reagent bottle
- 100ml pyrex glass reagent bottle
- Pipette
- Glass rod
- Plates
- 250ml Enlenmeyer flask
- 250ml conical flask

3.7 ANALYSIS OF PHYSICO CHEMICAL PARAMETERS

3.7.1 Temperature

A mercury thermometer with calibrations 0-100^{o}C was used to take readings of temperature of water and air sample at the time of sampling and the result is presented in the Appendix 1 below.

3.6.2 Colour

The colour of samples is determined using a Nessleriser and comparing them with standard dise NSA. Colour values are

read directly in Hazen unit on the platimium cobalt scale and results are presented in the Appendix.1.

3.7.3 Turbidity (NTU)

The turbidity of water samples are measured in the laboratory using the Lab Tech Signal Turbidity Meter. The value is read out directly in Nephelometric Unit. After the instrument have been standards. The result is presented in the Appendix.1.

3.7.4 pH

The pH of the samples is taken in the laboratory using an already standized pH meter with glass electrode model PHS-25 from REX instrument factory Shanghai. The result are presented in Appendix.1.

3.7.5 Electrical conductivity (μS)

The electrical conductivity of samples is measured using the battery operated conductivity bridge model MC-1 mark V electronic Switchgear at room temperature. The Volvos are read out directly in micro siemens when the result is presented in Appendix.1.

3.7.6 Sulphate (mg/l)

The turbid metric method is used. The sulphate ion is precipitated in a hydrochloric acid medium with barium chloride. The absorbance of the barium sulphate suspension is measured by Specrruollab 22 PC spectrophotometer. The sulphate ion of a reading with a standard cure and results are expressed as mg sulphate per liter of sample and result are recorded on appendix.1.

3.6.7 Total hardness {mg/l}

50ml of sample was pipetted into 250ml Evelenmeyer flask and a few drops of 0.1ml hydrochloric solution were added to it to dispose any hydrogen carbonate which would interfere with the determination. The solution was boiled to expel carbon dioxide, it was then cooled to 50^{o}C and 2ml buffer solution pH 10 (containing 67.5g ammonium chloride) and 57ml ammonium hydroxide in 1 liter of solution in distilled water were added. A small amount of enchrome black and loog of potassium chloride together to form a dry ponder was added and the solution was titrated against EDTA standard titrant (containing 7.5g ethlencdiamine) tetra acetic acid disodium salt and 0.1g

magnesium water 0.77g sodium hydroxide dilute to 1 liter and standardized against standard calcium carbonate solution to a blue colour end point (5 zentes, 1976). The total hardness was calculated from the relation.

Hardness /EDTA/as Mg1l calcium carbonate

$$\Rightarrow \frac{\text{M1 EDTA} * F * 1000 * 0.1 * 17.8}{\text{M1 of sample}}$$

Where F = mg calcium carbonate

M1 of EDTA

Result presented in Appendix .1.

3.7.8 Biological oxygen demand (bod) (mg/l)

The dissolved oxygen content of samples initially was taken. A known quality of samples was incubated with exclusion of light at 20^{o}C for days after which the final dissolved oxygen content is determined. The difference between the initial and final do gives the BOD^{5} of the sample in mg1L (APHA, 1971). Result are measured and presented in the Appendix .1.

3.7.9 Dissolved oxygen (mg/l)

Water sample for dissolved oxygen determination collected in 150ml pyrex glass reagent bottle were fixed on the spot according to wrinkers method. The bottle was completely filled with the water sample immediate after collection 1ml of wrinker solution. A magnesium sulphate in distilled water was added after which 1ml wrinkers solution B.

Alkaline potassium iodine solution was added to fix the oxygen. The prepared sampled bottle was quickly covered with air tight glass stoppers. The bottle was opened to dissolved sulphuric acid was added to dissolved any precipitation formed during the fixing 100ml of sample solution were titrated against 0.02N sodium thiosulphate solution using starch as an indicator and titrating to the disappearance of blue colour of the indicator in the solution. The dissolve oxygen was recorded in mg1l by multiplying by 2 and presented in Appendix.1.

3.7.10 Chloride (mg/l)

The argentometric method as described by APHA 1971 is used. Potassium chlormale is the indicator and result are

expressed as mg1l of sample and result is presented in the Appendix.1 below.

3.7.11 Nitrate (mg/l)

The phenol di-sulphuric acid method (AHPA 1971) was used and the optical density of the yellow product formed was measured with a spectrophotometer-SPECTRUMLAB-22-PC at 410nm. The nitrate ion concentration is determined by comparison of a reading with a standard curve and result expressed as mg nitrate per liter of sample and presented in the Appendix.1.

3.6.12 Phosphate (mg/l)

The ascorbic acid method (APHA, 1971) is used, Ammonium molybdate and potassium antimonyl tertrate react in an acid medium with dilute solution of orthophosphate to form an acid which is reduced to an intensely coloured molybdenum blue by ascorbic acid. The abundance of this blue product is measured with a spectrophotometer-SPECRUMLAB-22PP-88nm. The phosphate ion concentration was determined by comparism of the reading with a standard curve and result expressed as mg

phosphate per liter of sample and result being presented in Appendix.1.

3.7.13 Total dissolved solid (TDS) mg/l.

Filtered samples are evaporated and dried in weighed dishes at 105^{o}C to constant weight. The increase in weight over the empty dish represents the total dissolved solid cru tent. 100ml of the samples are used and the evaporating dishes are left to cool in desiccators before the weighing is done. The result are expressed in milligram per liter of sample and presented in Appendix.1.

3.7.14 Total suspended solid (TSS) (mg/l)

100ml of samples were filtered through a glass fiber filter disc and transferred to previously ignited and weighed evaporating dishes. The samples were the case of total dissolved solid and further dried at 105^{o}c for two hours in the oven. They were cooled in desiccators and weighed. The difference between the weigh obtained gave the valve of the total suspended solid content for the sample. The result were expressed in milligram

suspended solid per liter of sample and presented in appendix.1 below.

3.7.15 Iron (mg/l)

Spectrophotometric methods are used for the metal using the spectrum LAB-22PC Reagent- Phenanthroline Warelenght-510nm. Presented in Appendix.1.

3.6.16 Lead (mg/l)

Spectrophotometric methods are used for the metal using the spectrumlab-22PC

Reagent-Dethizone

Warelenght-52nm

Result are presented in appendix.1 below

3.6.17 Nickel (mg/l)

Spectrophotometric method are used for the metal using the spectrulab-22PC

Reagent-Dimethylglyoxime

Waveleght-445nm.

Result are presented in Appendix 1.

CHAPTER FOUR

RESULTS AND DISCUSSION

4.1 INTRODUCTION.

Water sample were collected at three different points along Nworie River and analysed. Results were presented and described with statistical tool as shown below.

Table 4.1 Descriptive Statistic of Nworie River

S\N	Parameters	Min	Max	Mean	STD	Variance
1.	Air Temp°C	20	23	21.33	1,25	1,56
2.	Water Temp°C	23	26	24.67	1.25	1.56
3.	Colour{pt/co}	5	10	6.67	2.36	5.56
4.	Turbidity {NTU}	0	1	0.67	0.47	0.22
5.	pH	5.2	5.75	5.53	0.24	0.06
6.	Electrical ConductivityμS	58	77	65	8.52	72.67
7.	TDS{mg/l}	38	50	42.33	5.44	29.56
8.	TSS{mg/l}	4	19	11.67	6.13	37.57
9.	DO{mg/l}	5.2	6.5	6.03	0.59	0.35
10.	BOD{mg/l}	0.4	0.7	0.53	0.14	0.02
11.	Chloride{mg/l}	13	16	14.67	1.25	1.56
12.	Sulphate{mg/l}	6.5	18	12.17	4.69	22.06
13.	Nitrate{mg/l}	0.061	0.076	0.07	0.0063	0.0047
14.	Phosphate{mg/l}	0.014	0.053	0.03	0.02	0.0030
15.	Iron{mg/l}	0.0	0.0	0.0	0.0	0.0
16.	Nickel{mg/l}	0.001	0.001	0.001	0.0	0.0
17.	Lead{mg/l}	0.011	0.018	0.014	0.0029	0.0006
18.	Cadmium{mg/l}	0.001	0.002	0.0016	0.0046	0.0002

STD = standard deviation

Table 4.2. Compares the mean of field samples with the ministry of environment existing standards, Federal ministry of Environment {1992} and World Health Organisation {1971}

S|N	PARAMETERS	MEAN Values	WHO	FME
1.	Air Temperature°C	21.33	Na	Na
2.	Water Temperature °C	24.67	Na	<15
3.	Colour {pt/co}	6.67	25	15
4.	Turbidity {NTU}	0.67	50	50
5.	Ph	5.53	7.0-8.5	6.5-8.5
6.	Electrical Conductivity{µS}	65.00	100	100
7.	Total Dissolved Solid {mg/l}	42.33	300	250
8.	Total Suspended Solid{mg/l}	11.67	50.00	50
9.	Dissolved Oxygen{mg/l}	6.03	4 – 5	2 – 3
10.	Biological Oxygen Demand{mg/l}	0.53	<3	<2
11	Chloride{mg/l}	14.67	200	600
12.	Sulphate {mg/l}	12.17	200	250
13.	Nitrate {mg/l}	0.03	40	10
14.	Phosphate {mg/l}	0.0	5	5
15.	Iron {mg/l}	0.14	1	0.3
16.	Nickel {mg/l}	0.077	0.001	0.10
17	Lead {mg/l}	0.001	0.05	0.05
18..	Cadmium {mg/l}	0.00167	0.01	0.010

All parameters in mg/lexcept otherwise stated

NA= not applicable

4.2 PHYSICAL PARAMETERS

4.2.1 Water temperature ºC

Temperature at all points agrees with the established standards (25 -27°C), Results agrees with Nnaji et al (2010). Temperature results from organic and inorganic pollution sources which are washed or discharge into the river body. Higher temperature may scare organism away from its habitat.

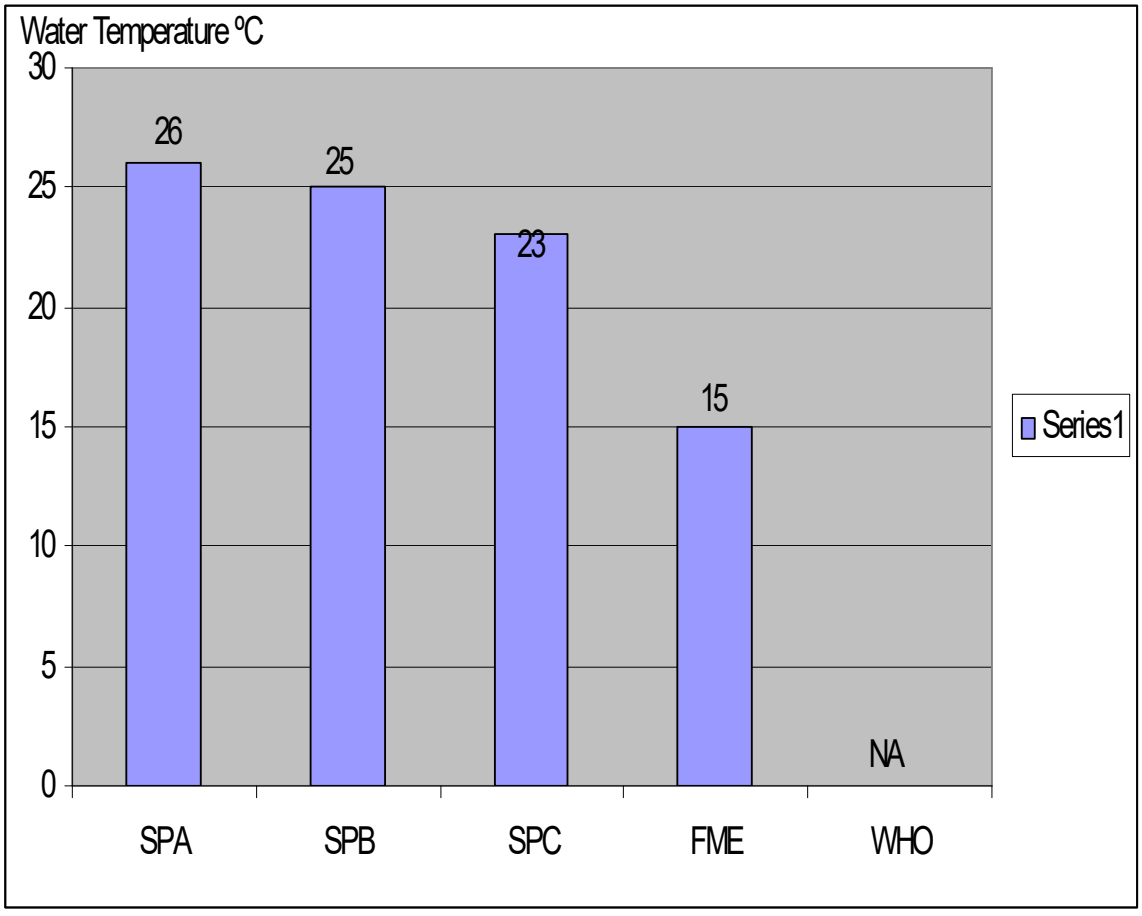

Fig.4.1: The variation in Water Temperature {ºC} of Nworie River at various sampling points including the FME and WHO standards.

4.2.2 Colour (pt/co)

Colour at all sampling points never exceeded the threshold limit of WHO\FME standards. Sampling at point A {10 pt\co} shows the highest variations in colour than other stations, results supported by Acholonu et al, (2009) and Duru et al, (2009).colour in water could be caused by excessive growth of organism, decay of organic matter, and other inorganics in water.

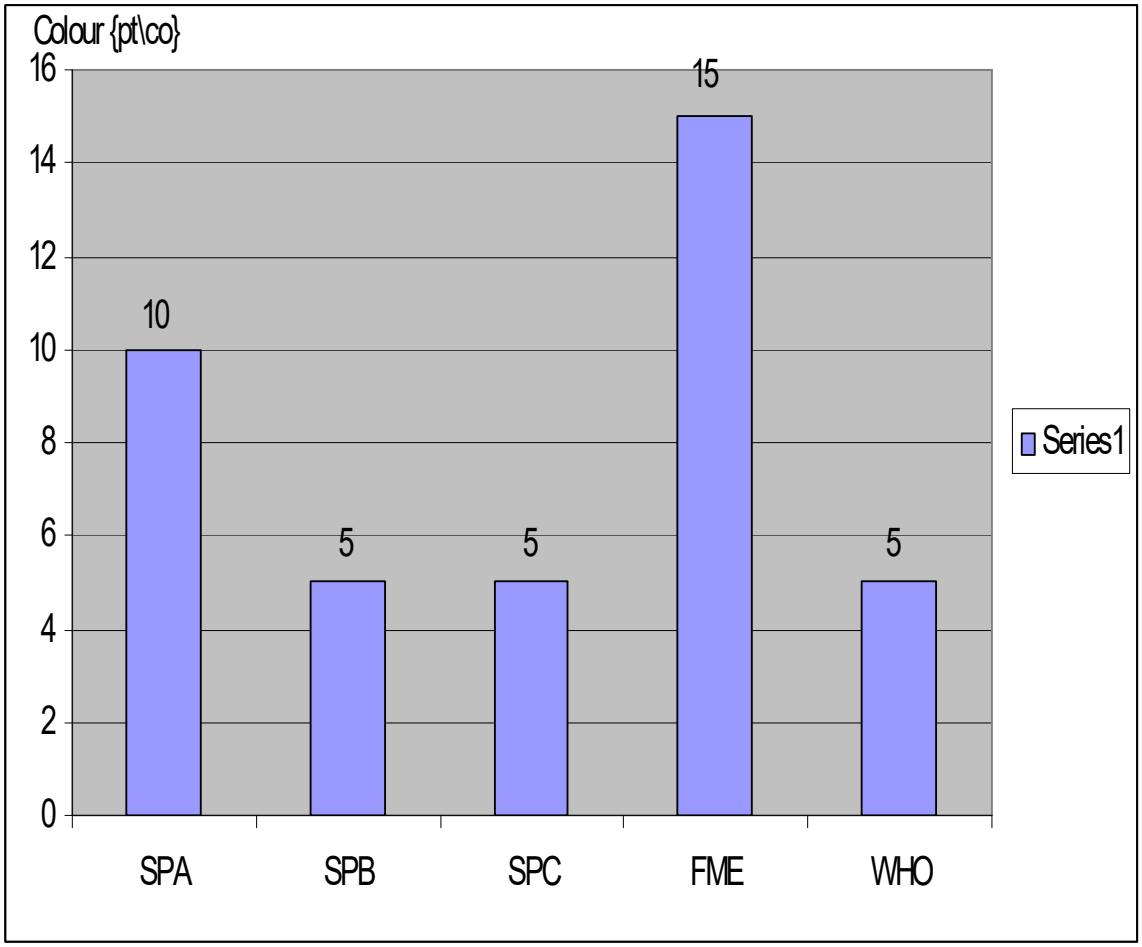

Fig.4.2: The variation in colour {pt/co} of Nworie River at various sampling points including the FME and WHO standards.

4.2.3 Turbidity {NTU}

At all points the turbidity ranged from {0 – 1 NTU} which indicate that the colloidal or finely divided suspended matters and other factors such as runoff, leaves from trees that contributes to turbidity in the water are very minimal. Turbidity, hinders the production of food in river because the process of photosynthesis is affected (Hammer, 1977)

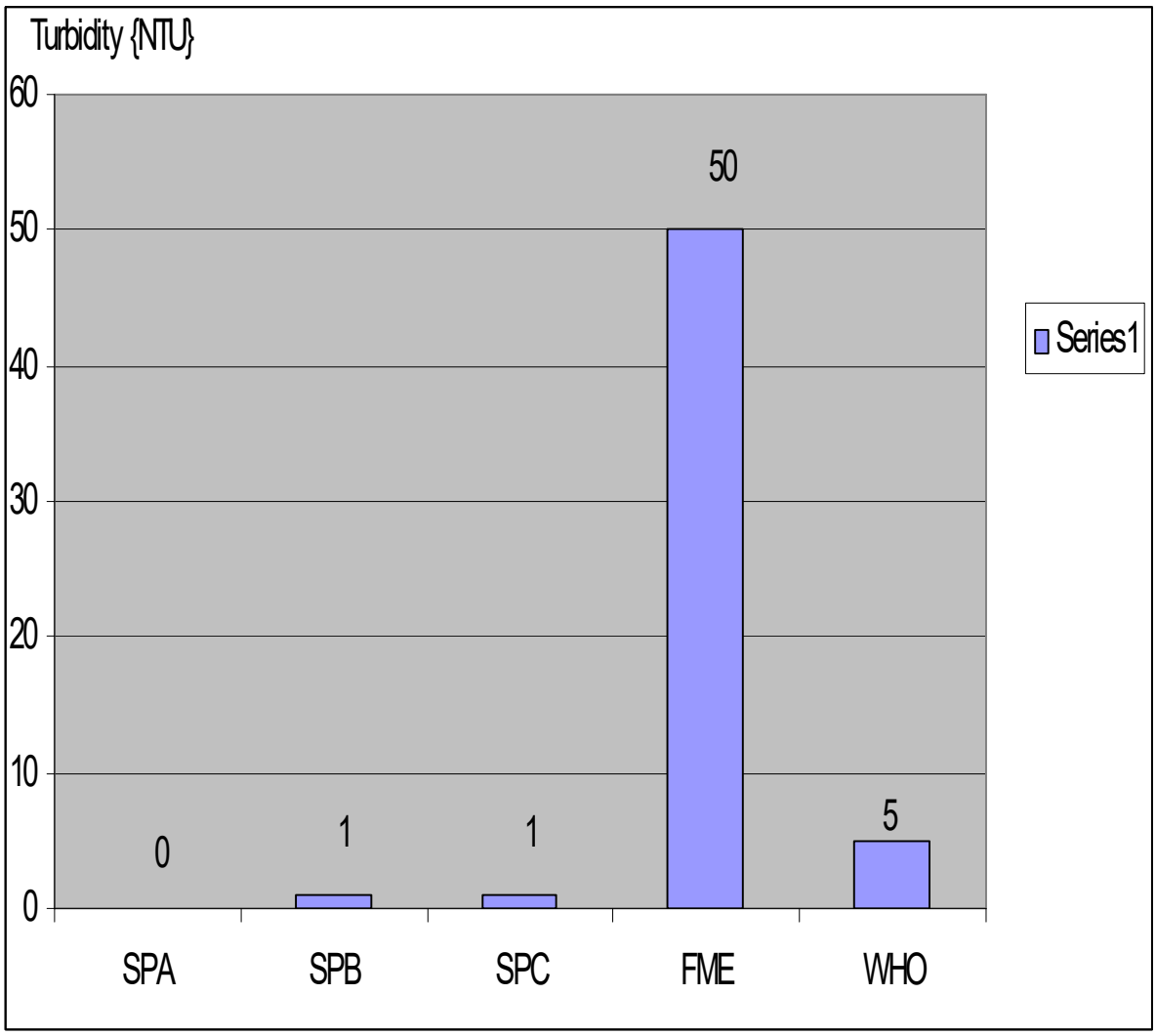

Fig.4.3: The variation in turbidity {NTU} of Nworie River at various sampling points including the FME and WHO standards.

4.2.4 **Electrical conductivity** { µS}

The electrical conductivity (µS) ranged from (58.0 -77(µS) but never exceeded the recommended standards of WHO\FME. The electrical conductivity (µS) results from ionizable dissolved minerals salt washed into the river from the pollution sources.

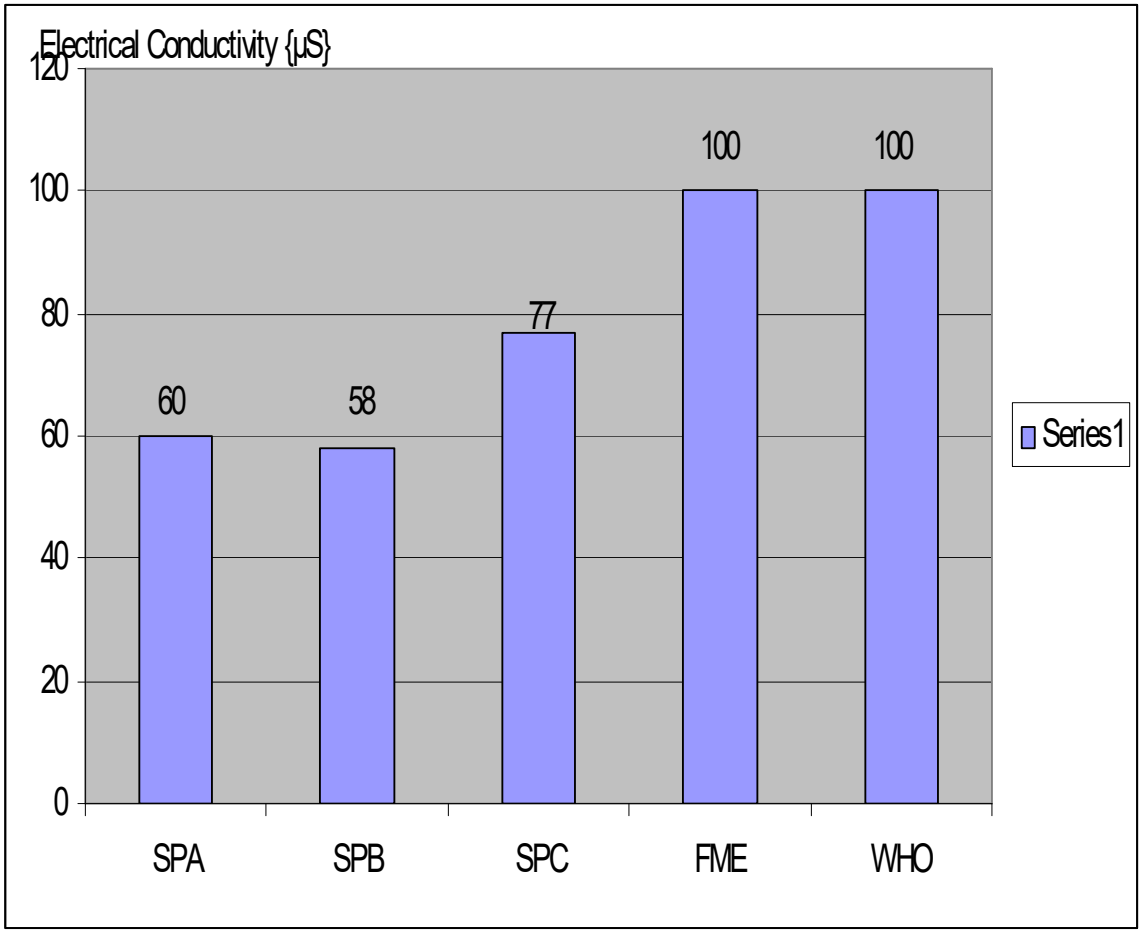

Fig 4.4: The variation in Electrical conductivity {µS} of Nworie River at various sampling points including the FME and WHO standards.

4.2.5 Total dissolved solid {TDS}{MG\L}

The total dissolved solid ranged from 38.00-50.00mg/l, this fall inline with the WHO| FME standards. The result supported by Acholonu, et al 2008. Total dissolved solid results from

inorganic pollutants comprises of mineral acids, inorganic salt, finely divided metal arising from domestic, agricultural and industrial sources.{Akionbare, 2009}.

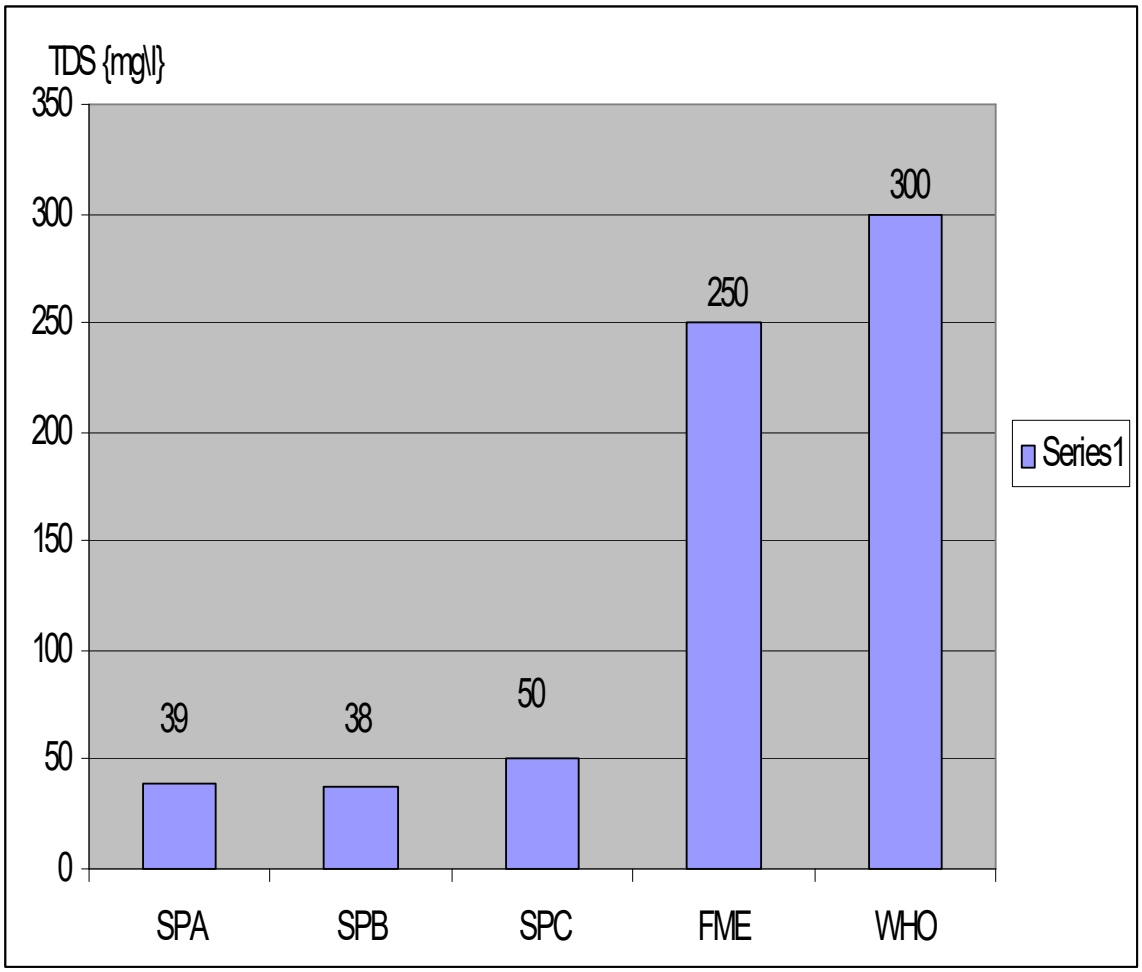

Fig.4.5: The variation in Total dissolved solid {mg\l} of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.2.6 Total suspended solid {TSS} {MG\L}

The total suspended solid analyzed ranged from 4.0-19.0mg/l, station B with concentration of 12mg/|l. this analysis is supported by Acholonu et al (2009) and Nnaji et al (2010). Total suspended solid arise from finely divided suspended matters which settle slowly and with difficult. (kionbare, 2009).

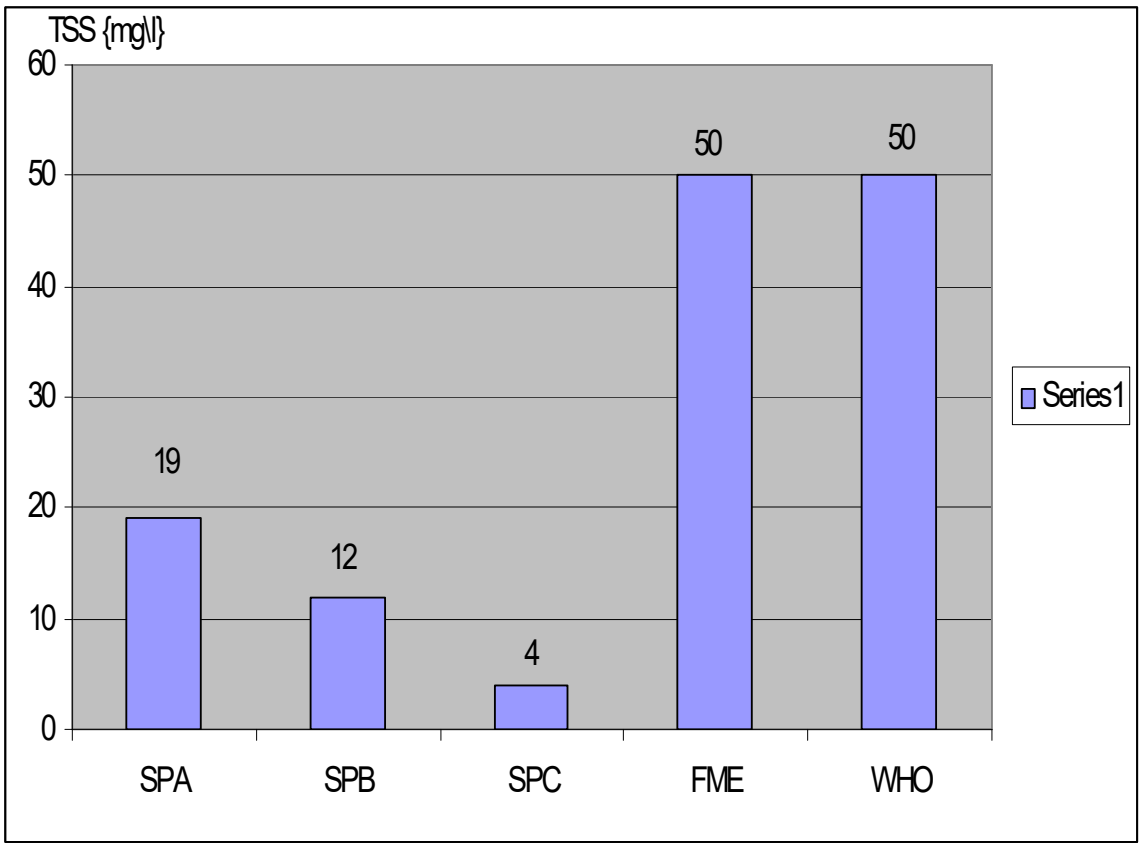

Fig.4.6: The variation in Total suspended solid {TSS} {MG\L} of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3 CHEMICAL PARAMETERS

4.3.1 pH

The pH valve of the sample analyzed ranges from (5.20 – 5.75), this fell against the recommended WHO\FME standards indicating the Nworie fall within the acidic medium. Results inline with Acholonu et al, (2009). This could be as a result of laundry activities at the sites. It also result from soil, begin acidic as it recharges the water from groundwater. The pH of 6.5 -9.0 is most appropriate for the maintenance of fish communities
(Nwaogazie et al,1997).

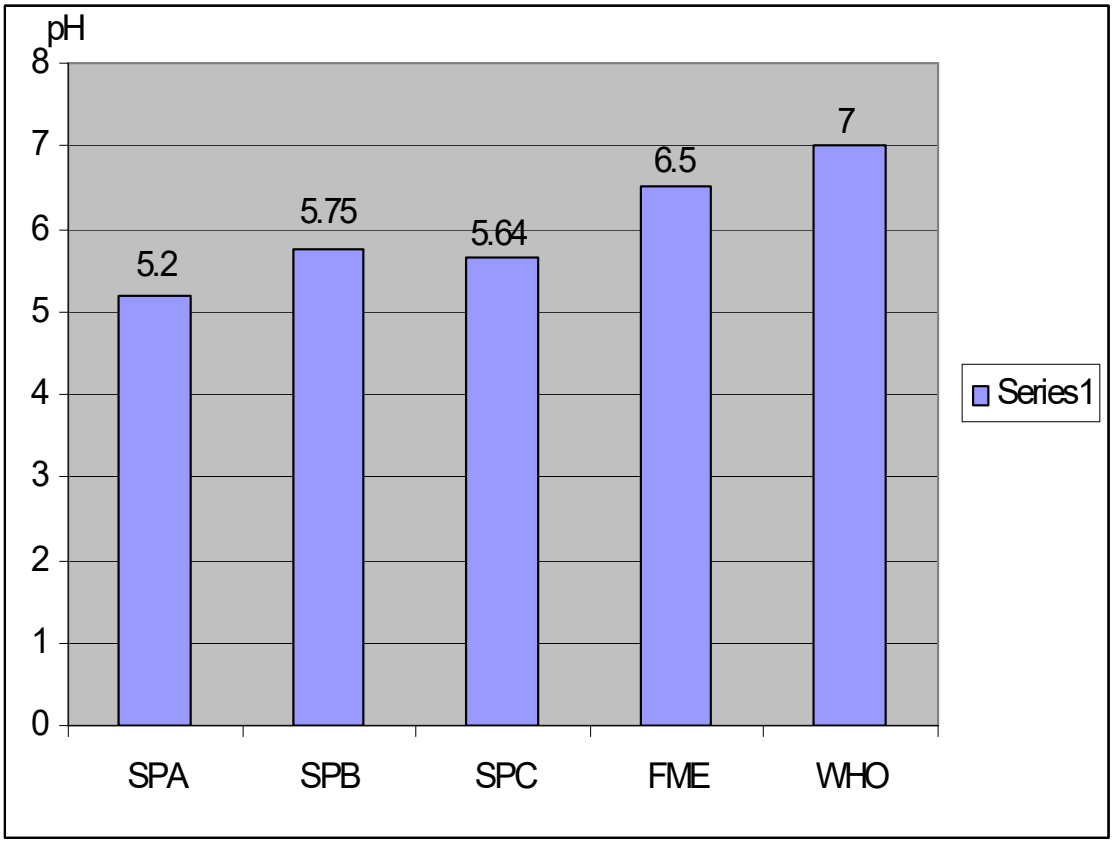

Fig.4.7: The variation in pH of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3.2 Dissolved oxygen {mg/l}

The results obtained from the analysis of dissolved oxygen ranged from 5.2 -6.5{mg/l} and within the acceptable range of WHO|FME standards. This result is supported by Nnaji et al, 2010. Decrease in dissolved oxygen in water is caused by

organic wastes. At very low concentration it may cause fish kills (EPA, 1985)

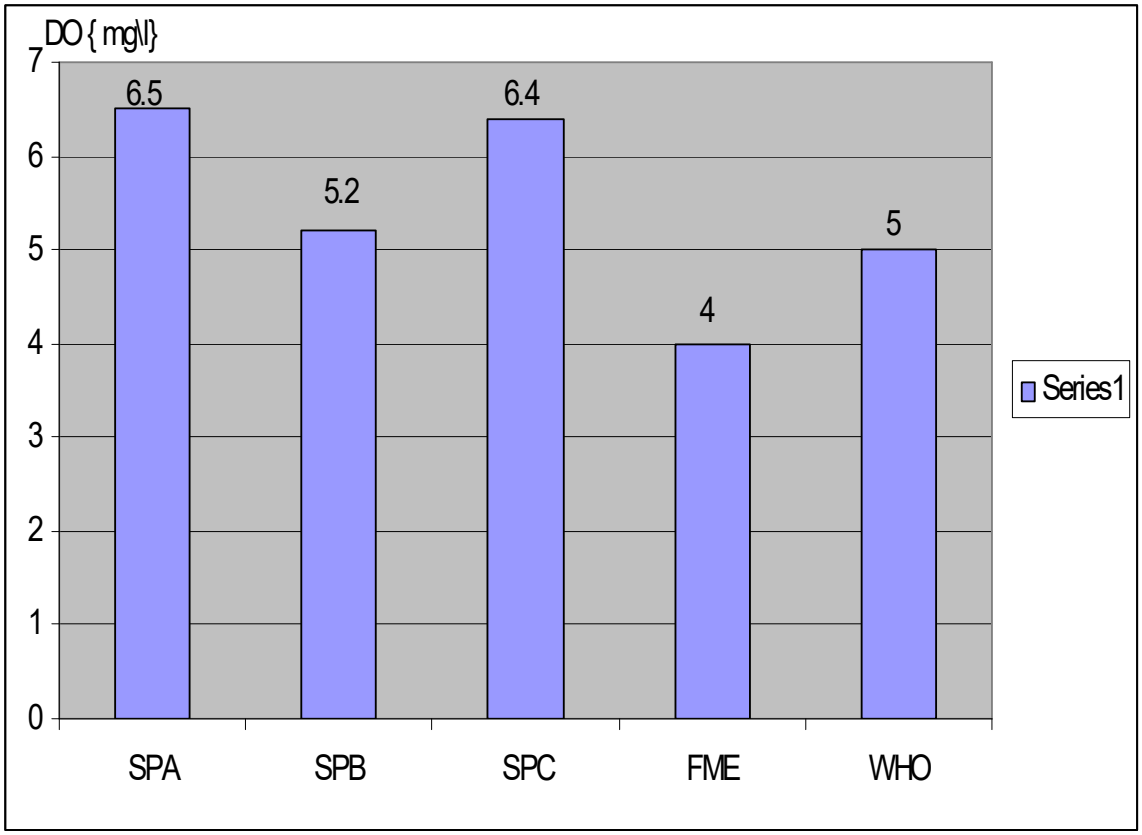

Fig.4.8: The variation in Dissolved Oxygen {mg\l}f Nworie River at various sampling points including the federal ministry of environment and world health organization standard

4.3.3 Chloride {mg/l}

The variations in chloride (mg/l) ranged between (13 - 16mg/l) hence are within the acceptable limit of WHO/FME standards. This result is supported by Duru et al, (2009) and

Acholonu et al (2009). This indicates that pollutants from the site contain no chloride contaminant. This may have no effect on aquatic

life.

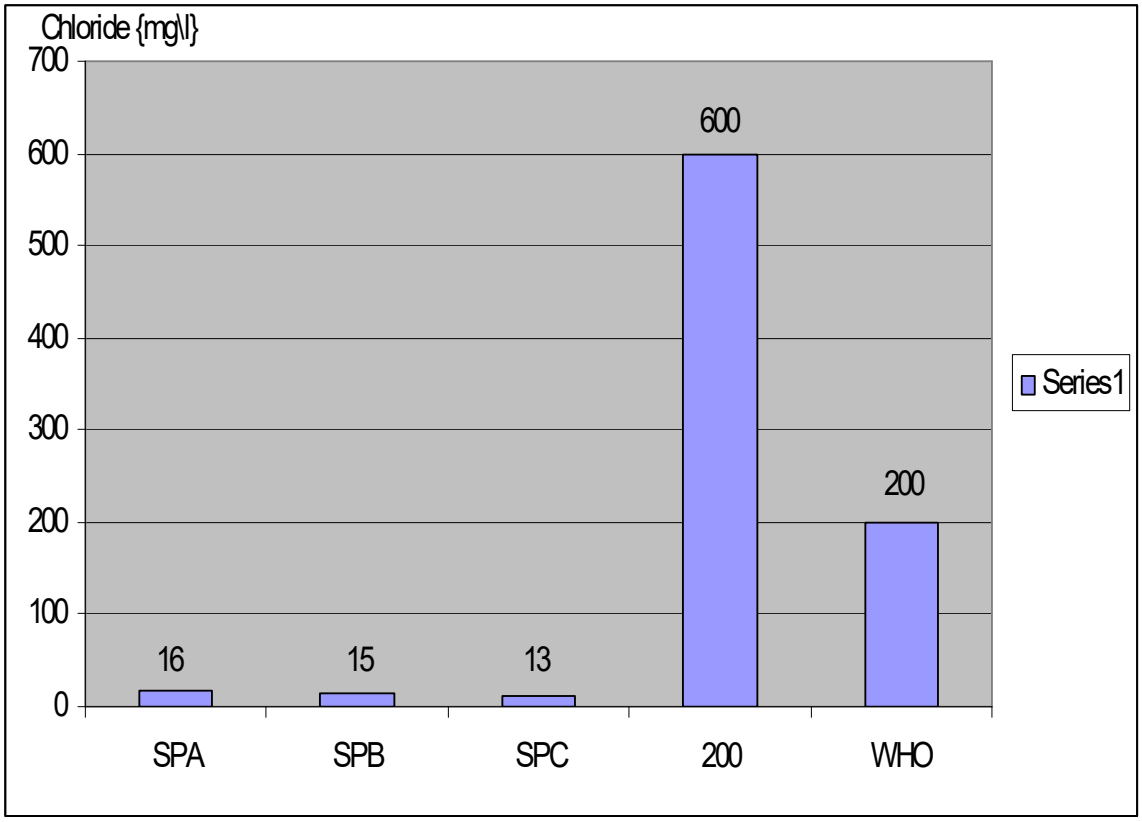

Fig. 4.9: The variation in Chloride {mg\l} of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3.4 Sulphate {mg/l}

The analysis shows that sulphate falls between the range of 6.5 -18mg/l and this is within the recommended limit.

This indicates that sources that generate sulphate are minimal in the site and may not affect the river. Sulphates are generated by industrial effluent, other domestic activities.

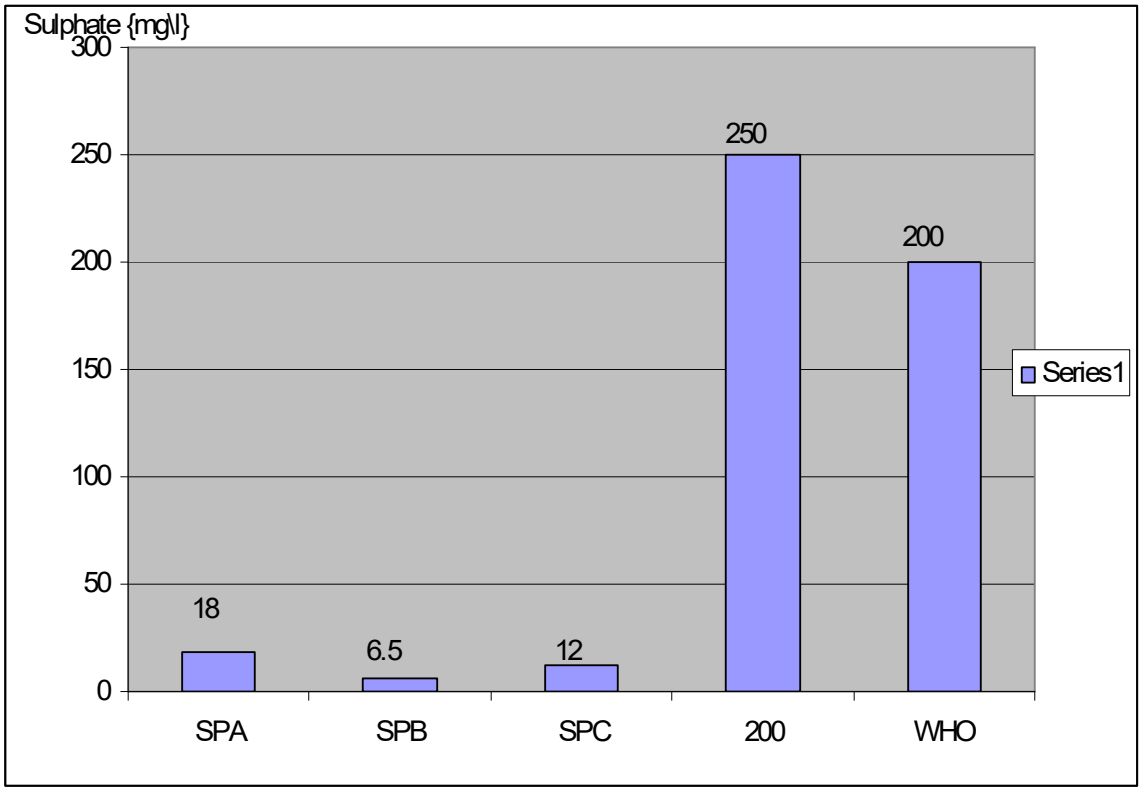

Fig. 4.10: The variation in Sulphate {mg\l} of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3.5 Nickel {mg/l}

Nickel concentrations ranges from 0.011 -0.018mg|l, this falls within the recommended standards of WHO/FME. The results supported by Nnaji et al, 2010. Nickel sources from inorganic pollutant from refuse dumps, domestic activities, industrial etc.

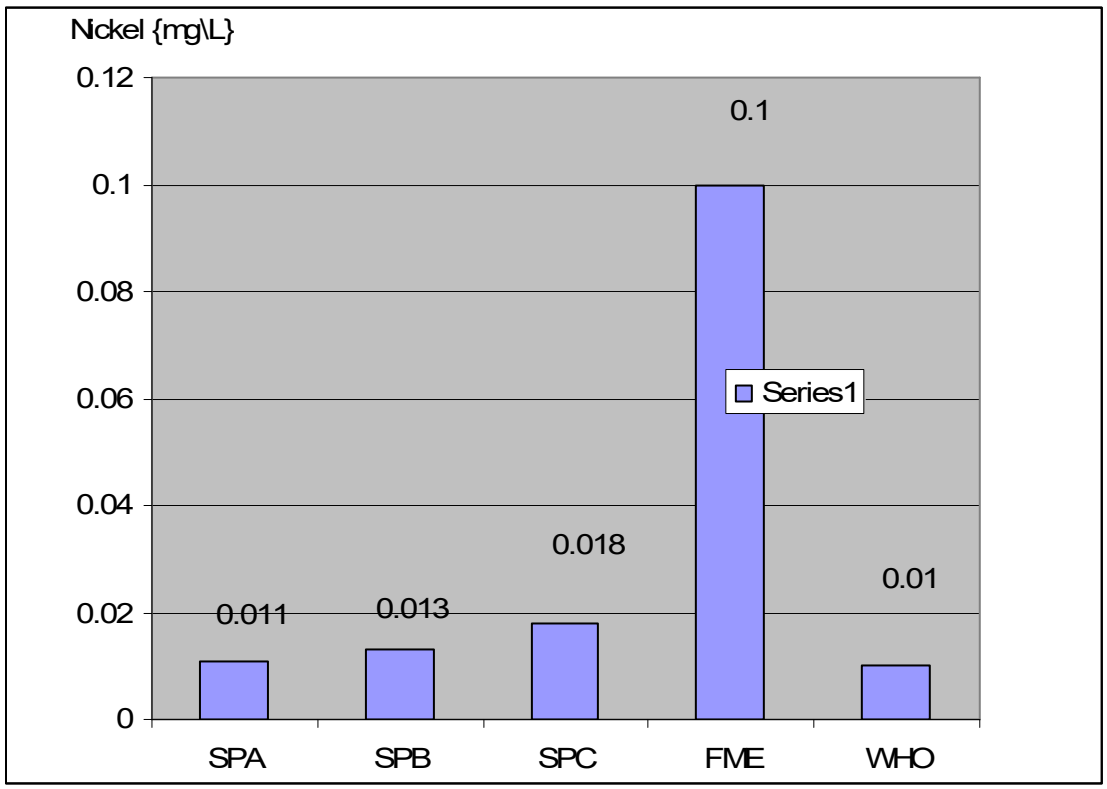

Fig. 4.11: The variation in Nickel {MG\L} of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3.6 Lead {mg/l}

Lead at all stations was found to have equal concentrations of 0.001mg/l. at this concentration is falls in agreement with established standards of WHO/FME. Lead sources from inorganic and materials containing lead generate from domestic, commercials, agriculture add to the concentration in the river, etc. lead at a concentration of 1mg/l is found to be poisonous to aquatic life (Epa 1985).

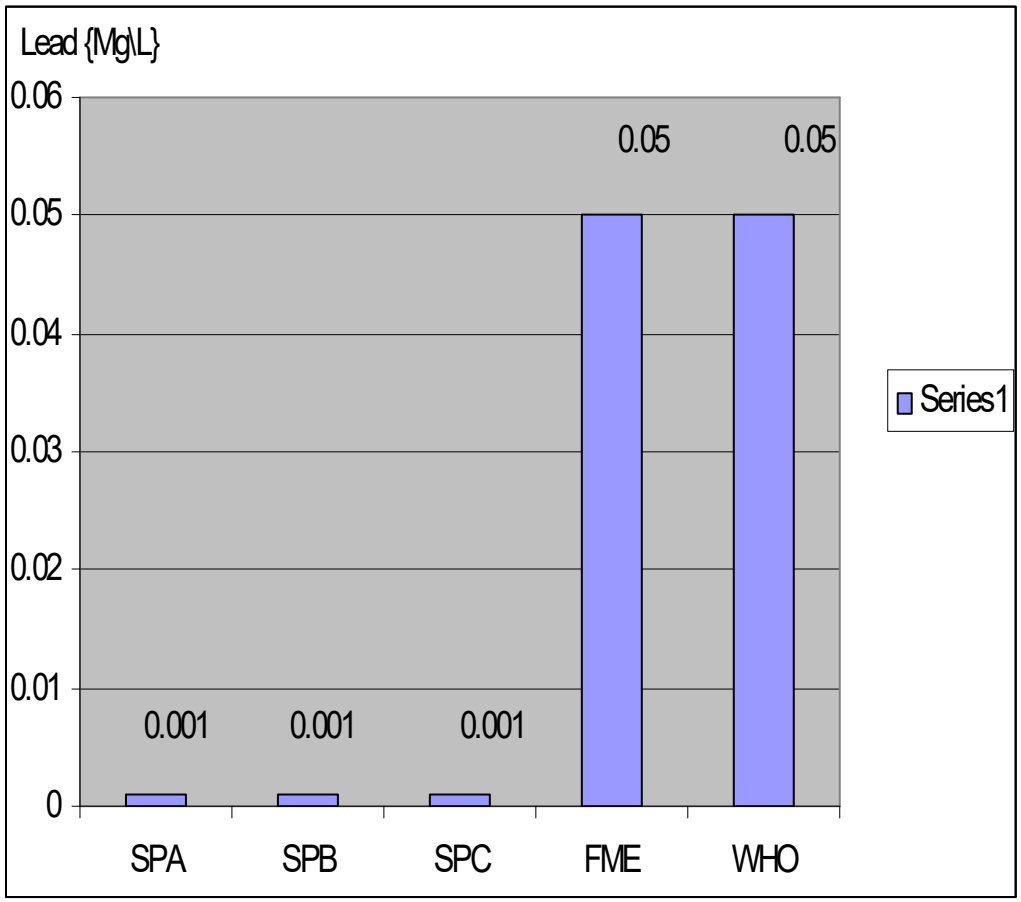

Fig.4.12: The variation in Lead MG\L of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3.7 Cadimium {mg/l}

Cadmium ranges from 0.001 – 0.002mg/l in concentration and this is in agreement with the WHO/FME standards. This result is supported by Nnaji et al (2010). Cadmium deserves it sources from domestic, agricultural activities etc. At high

concentration of 1mg/l is capable of killing flora and fauna (Epa, 1985).

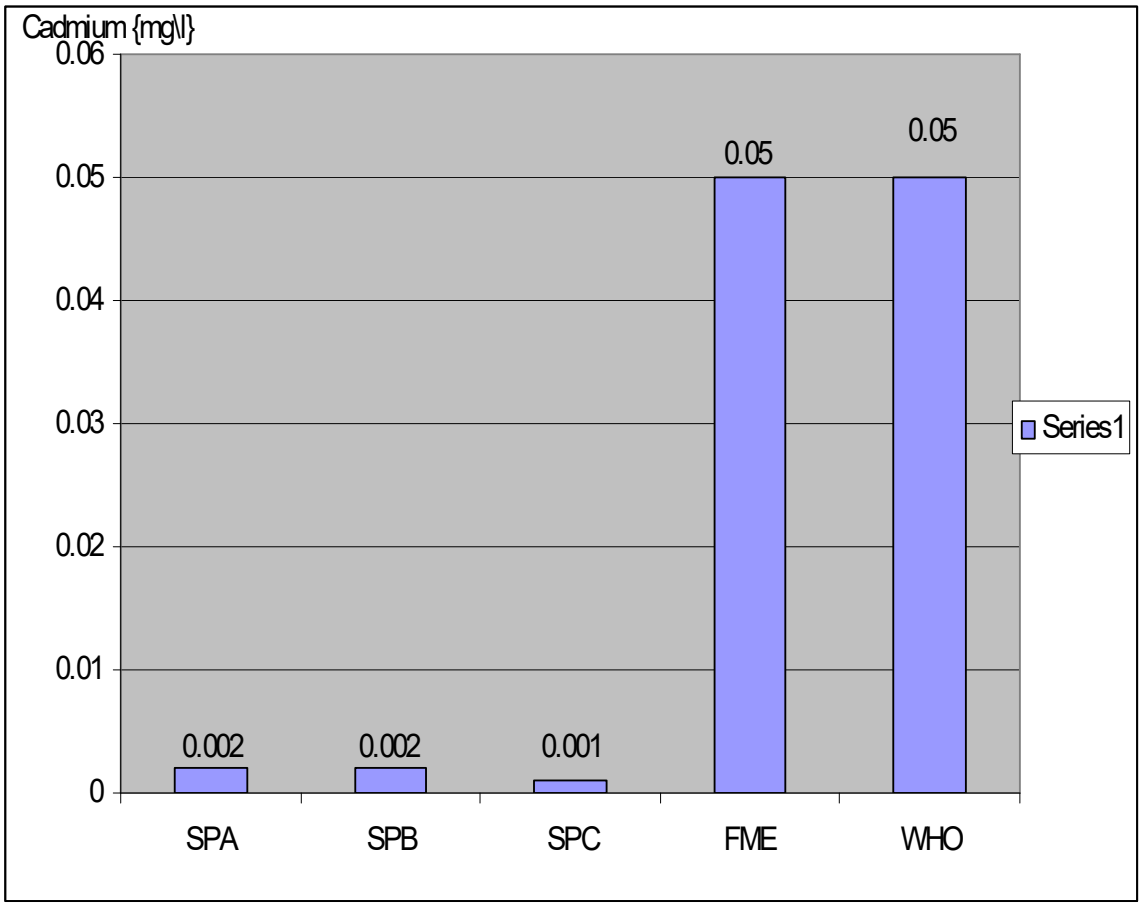

Fig. 4 13: The variation in Cadmium MG\L of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3.8 Iron{mg/l}

At all stations no concentration was found for iron, this is in line with WHO/FME standards which state that concentration at this level should not exceed 0.3mg/l. this analysis is supported by Nnaji et al (2010). The concentrations in iron results from presence of geological materials present containing iron, other domestic sources including batteries. At concentration over 1mg|1 has an effect on aquatic life and may bioaccumulate in tissues. (Epa 1985). Iron affects laundry.

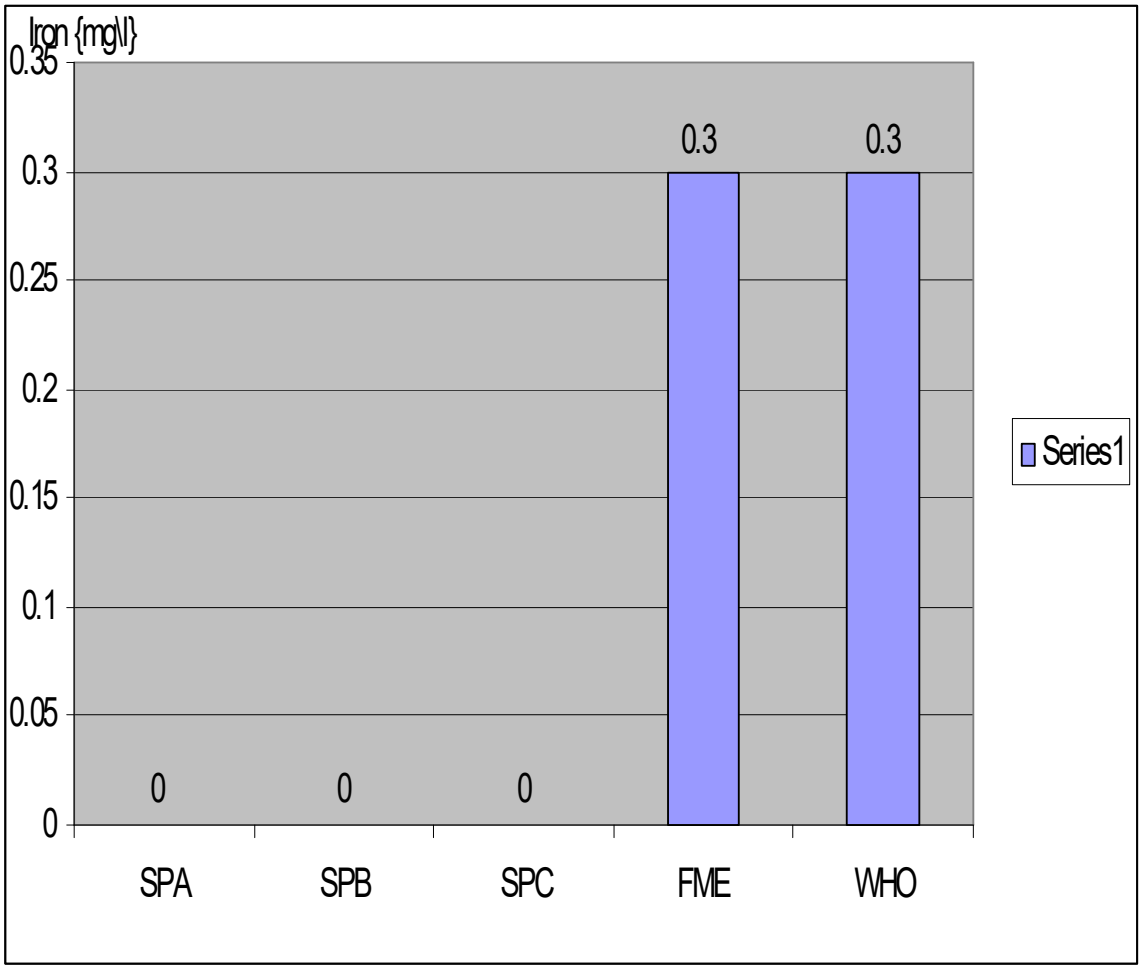

Fig.4.13: The variation in Iron {MG\L} of Nworie River at various sampling points including the federal ministry of environment and world health organization standard.

4.3.9 Biological Oxygen Demand {BOD} {mg\l}

The biological oxygen demand ranged from 0.4 -0.7 {mg\l], hence this fell within the regulation WHO\FME standards. This

result is supported by Acholonu et al (2009). This could be as a result of oxygen demanding waste, such from agriculture, domestic activities etc washed into Nworie River are easily carried by the river flow, hence not affecting the river.

4.3.10 Phosphate {mg/l}

Phosphate ranged from 0.014-0.053mg/l, this falls within the recommendable WHO/FME standards. Analysis in line with Duru et al, 2009. And likely to cause no harm to the river at this concentrations. Phosphate results inorganic pollutant leached from refuse dump, also fertilizer runoff from farmlands.

4.3.11 Nitrate {mg/l}

The concentration of nitrate at all stations ranges from 0.061 -0.076 mg/l, is in agreement with the WHO|FME standards. This analysis is supported by Nnaji et al (2010). Nitrate is generated mainly by agricultural sources, other domestic activities etc.

CHAPTER FIVE

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

This study was carried out on the assessment of water quality of Nworie River. Result from the laboratory showed that with the exception of pH, the water quality of Nworie river did not exceeded the thresholds of WHO/FME water quality standards. Thus generally speaking, the chemical pollutants in the river did not exceed water quality standards. Judging from the physical appearance of the river at various stations, it was expected that chemical contaminant in the water would be high. This could be attributed to the fact that lotic bodies of the water are in constant flow and that contaminant spots or stations becomes clear or less turbid.

Meanwhile, the study shows that the decrease in pH could be attributed to institutional activities such as effluent from hospitals: agricultural activities like the animal dumps from Alvan Ikoku Federal College of Education, and open dump site along the river banks hence showing that the river quality of Nworie river is acidic and could be classified as polluted if the trends is not properly checked, the water quality of Nworie will restrict its sustainable use by the residents.

5.2 RECOMMENDATIONS

Based on the discussion and findings the study preffers the following recommendations.

Sampling of the river should be equally include that of fish and plants for detailed study on the effect of pH on aquatic lives. Work should be done on the biological or microbial profile of the river and also during raining seasons to ascertain their concentrations in both seasons in order to know the inherent danger, if any.

In addition, there should be reconstruction of bridges crossing the river that impedes its free flows along.

Meanwhile, the government should provide sanitary method of waste disposal system such as engineered sanitary landfill or incinerator system for proper waste disposal as to avoid easily deposition of waste to the river from the resident. Also government should equally provide alternative sources of water supply such as pipe borne water, borehole with appropriate treatment for Owerri residents.

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Appendix 1

Water Analysis Results

Quality parameter	A	B	C
Colour {pt|co}	10	5	5
Temperature °C	26	25	23
pH	5.2	5.75	5.64
Electrical conductivity µS	60	58	77
TDS{mg|l}	39	38	50
TSS{mg|l}	19	12	4
DO {mg|l}	6.5	5.2	6.4
BOD{mg|l}	0.7	0.4	0.5
Chloride {mg|l}	16	15	13
Sulphate {mg|l}	18	6.5	12
Nitrate {mg|l}	0.061	0.065	0.076
Phosphate {mg|l}	0.018	0.014	0.053
Iron {mg|l}	0.0	0.0	0.0
Lead {mg|l}	0.001	0.001	0.001
Nickel{mg|l}	0.011	0.013	0.018
Cadmium {mg|l}	0.002	0.002	0.002