

**EFFECT OF WASTE DISPOSAL ON WATER QUALITY OF OPEN  
SHALLOW WELLS IN KPAKUNGU, MINNA**

**BY**

**ATTAH, OZUZOMA FUNMILAYO**

**2004/18359EA**

**DEPARTMENT OF AGRICULTURAL AND BIORESOURCES  
ENGINEERING  
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA,  
NIGER STATE, NIGERIA**

**FEBRUARY, 2010.**

**EFFECT OF WASTE DISPOSAL ON WATER QUALITY OF OPEN  
SHALLOW WELLS IN KPAKUNGU, MINNA**

**BY**

**ATTAH, OZUZOMA FUNMILAYO**

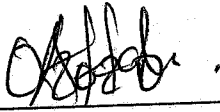
**2004/18359EA**

**BEING A FINAL YEAR PROJECT REPORT SUBMITTED IN  
PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE  
AWARD OF BACHELOR OF ENGINEERING (B. ENG) DEGREE IN  
AGRICULTURAL AND BIORESOURCES ENGINEERING,  
FEDERAL UNIVERSITY OF TECHNOLOGY, MINNA, NIGER  
STATE.**

**FEBRUARY, 2010.**

## DECLARATION

I hereby declare that this project work is a record of a research work that was undertaken and written by me. It has not been presented before for any degree or diploma or certificate at any university or institution. Information derived from personal communications, published and unpublished work were duly referenced in the text.



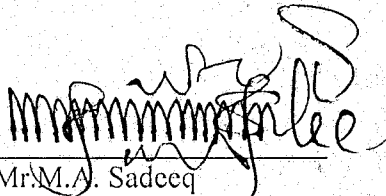
Attah, Ozozoma Funmilayo

18 / 02 / 2010

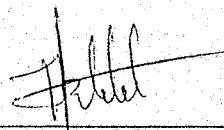
Date

## CERTIFICATION

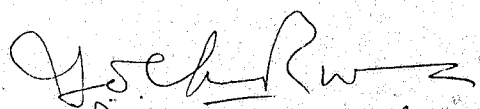
This project entitled "Effect of Waste Disposal on Water Quality of Open Shallow Wells in Kpakungu, Minna" by Attah, Ozozoma Funmilayo, meets the regulations governing the award of the degree of Bachelor of Engineering (B.ENG.) of the Federal University of Technology, Minna, and it is approved for its contribution to scientific knowledge and literary presentation.

  
Mr. M. A. Sadceq  
Supervisor

17/02/2010  
Date

  
Engr. Dr. A. A. Balami  
H.O.D, Agricultural and Bioresources Engineering

17/02/10  
Date

  
Engr. Prof. G. O. Chukwura  
External Examiner

10-02-10  
Date

## **DEDICATION**

I specially dedicate this work to God Almighty, the maker of my life, the creator of Heaven and earth. I also dedicate this project work to my Dad and Mum for their full support, prayer and encouragement.

## ACKNOWLEDGEMENTS

Thanks to God the Most High, for his grace, love, favour, guidance and protection over my life and giving me wisdom, knowledge, understanding and strength to accomplish this project work.

The progress and completion of this project work wouldn't have been possible without various contributions from different individuals not just during the work period alone but throughout the entire five years program.

With deep sense of appreciation, I am grateful to my supervisor, Engr. M.A Sadeeq who through his dedication, contributions and commitment has made this project a success. I appreciate the material, spiritual and financial supports from my lovely sister Ozofu Aweto (Mrs.) and the rest of my family members for the love you all showed to me during this period.

My sincere gratitude also goes to the Head of my Department, Eng. Dr. A. Balami and all the Staff of Agricultural and Bioresources Engineering Department, especially to, Mallam Aliyu.

A friend I will always appreciate and cherish Mmaduabuchi, for his endless support and encouragement through the years. To Ngozi for her sisterly support, my friends Rosemary, Chikodili, Orobosa and a lots of others who have contributed in no small measure to actualizing my dreams.

## ABSTRACT

An assessment of physio-chemical and bacteriological analysis of the domesticated open shallow wells was carried out in order to ascertain the effect of dump site on water quality in kpakungu area of Minna. Three different water samples were collected from three different open shallow wells, 120m and 150m apart. Laboratory analyses was carried out on the samples using the suitable reagent for each case (physical, chemical and bacteriological contaminant) to compare the results obtained with the WHO 2007 and NIS 554 standards. The results obtained from all the samples show that the chemical contaminants Mn (0.022, 0.07, 0.106), Zn (0.04, 0.07, 0.11), Cr (0.00043, 0.00043, 0.00014) was not in excess compared to the WHO and NIS554 standard values. While the amount of bacteriological contaminant was found to be more in all the samples for total coli form (204, 160, 75) and E.coli (4, 3, 15), this implies that the water is not suitable for drinking. These results shows that there is a strong correlation between the refuse dump sites and ground water pollution, therefore measures need to be taken to address the problem.

## TABLE OF CONTENTS

Title	Page
Cover page	
Title page	i
Declaration	ii
Certification	iii
Dedication	iv
Acknowledgements	v
Abstract	vi
Table of content	vii-ix
List of tables	x
List of plates	xi
Abbreviations	xii
List of Appendices	xiii
<b>CHAPTER ONE</b>	
1. INTRODUCTION	1
1.1 Background of Study	5
1.2 Statement of the Problem	5
1.3 Objective of the Study	5
1.4 Scope of the Project	5
1.5 Justification of the Study	5
1.6 Limitation of the Study	6



## CHAPTER TWO

2.	LITERATURE REVIEW	7
2.1	Water Quality	7
2.1.1	Standards Followed	8
2.1.2	Physical Contaminants	8
2.1.3.	Chemical Contaminants	8
2.1.4.	Bacteriological Contaminants	9
2.2.	Source of Water Pollution	9
2.3.	Chemical Examination of Water	10
2.4.	Groundwater Contamination from a Waste Disposal	11
2.4.1	Effect of Physical Contaminant to Groundwater Quality	11
2.4.2	Effect of Bacteriological Contaminant to Groundwater Quality	11
2.5.	Effect of Chemical (Heavy Metals) Contaminant to Groundwater Quality	11
2.5.1	Effect of Manganese:	11
2.5.2	Effect of Zinc:	12
2.5.3	Effect of Chromium:	13
2.6.	Treatment Methods for Heavy Metals (Zn, Mn, Cr) Removal	13
2.6.1	Removal of Manganese:	14
2.6.2	Removal of Zinc:	14
2.6.3	Removal of Chromium:	14

## CHAPTER THREE

3.	MATERIALS AND METHODS	16
3.1	Study Area	16

3.2	Sample Size Determination	16
3.3	Physical Analysis Procedure	17
3.3.1	Turbidity Determination	17
3.3.2	Colour	18
3.4	Chemical Analysis Procedure	18
3.4.1	Determination of Conductivity	18
3.4.2	Determination of Alkalinity	19
3.4.3	Determination of Chromium	19
3.4.4	Determination of Chloride	20
3.4.5	Determination of Zinc	20
3.4.6	Determination of Iron	21
3.4.7	Determination of Manganese	22
3.5	Biological Analysis Procedure	22
3.6	Health Implication	
<b>25CHAPTER FOUR</b>		
4.	<b>RESULTS AND DISCUSSION</b>	26
4.1	Results	28
4.2	Discussion	29
<b>CHAPTER FIVE</b>		
5.	<b>CONCLUSIONS AND RECOMMENDATIONS</b>	31
5.1	Conclusions	31
5.2	Recommendations	31

REFERENCES

33

APPENDICES

34

## LIST OF TABLES

Table		Page
4.1:	Result of Physio- chemical Analysis	
4.2	Variance for Water Sample One	28
4.3	Variance for Water Sample Two	29
4.4	Variance for Water Sample Three	30

## LIST OF PLATES

Plate	Page
3.1: Refuse dump site	35
3.2: Affected well one	35
3.3: Affected well two	35

## ABBREVIATIONS

### Acronyms

W H O

NIS 554

### Meaning

World Health Organization

Nigerian Industrial Standards

s

## LIST OF APPENDICES

### Appendix

A:	WHO and NIS554 Standards	34
B:	Refuse Dumps site and Affected wells I and II at Kpakungu	35
C:	Water Chemical Pollutants	36

## CHAPTER ONE

### 1. INTRODUCTION

#### 1.1 Background of Study

Ground water makes up about twenty percent (20%) of the world's fresh water supply, which is about 0.61% of the entire world's water, including oceans and permanent ice (MacDonnell, 1996). Ground water is naturally replenished by surface water from precipitation, streams and rivers when this recharge reaches the water table. It is estimated that the volume of ground water comprises 30.1% of all fresh water resource on earth compared to 0.3% of surface fresh water. Ground water can be a long term reservoir of the natural water cycle. It comes from rain, snow, sleet, and hail that soaks into the ground. The water moves down into the ground due to gravity, passing through different soil strata it reaches a point of saturation.

The simplest and oldest way of collecting ground water is by digging into ground, hence penetrating the water table. If the quantity of water that can be taken from the hole is not adequate, then the hole must be extended either horizontally or vertically. The method chosen depends on the local geohydrology.

If the hole is extended horizontally it becomes an open collecting ditch. On the other hand, vertical extension of the whole makes it a dug or drilled well, or a bore hole. This method can be used when the aquifer is of sufficient thickness, and in any case when the aquifer is more than about 6m below ground level. Dug wells are usually 1m or more in diameter (Wilson, 1990).

The common method for exploiting ground water is by use of well. A water well is the universal term used for holes or shaft usually vertically excavated in the earth for bringing ground water to the surface. Hole that extends vertically into the water bearing formation below



the ground surface are also known as well. The quantity of water that can be drawn from a well is known as yield. Efficient and economical utilization of ground water through wells depend on the design of the well to best suit the water bearing formations. Wells can be classified as shallow and deep wells. Depending on the depth of the pumping water level from ground surface. Wells having a pumping water level at 6m or less from the ground surface are usually classified as shallow or surface wells. While those in excess of 6m in depth as deep wells.

Ground water is valuable resource often used for industry, commerce, agriculture and most importantly for drinking. It is an important source of portable water for rural and medium sized communities in Nigeria (Samaila, 2004). The raw water used for domestic purpose is vulnerable to contamination due to the influence of domestic wastes and other influence. The ground water pollution is mainly due to the process of industrialization and urbanization that has progressively developed overtime, without any regard for environmental consequences (Elendu, 2006).

Protection of ground water is one of the major environmental issues, through water from such sources are suitable for drinking water since it is less exposed to pollutants, which may be present in surface water. Often, surface water needs very expensive chemical treatments before it could be used for drinking. However, ground water could be exploited and used without any chemical treatment.

Water is polluted when it is altered in composition, directly or indirectly as a result of the activities of man. The polluted water becomes less suitable for any meaningful domestic use. Kpakungu as a community 3-5 decades ago was known to be the Minna waste dumping site. This environmental unfriendly act has culminated into the concentration of impurities and other forms of water contaminants flowing as aquifers of most shallow wells within the locality. This

scenario has altered the physio-chemical properties of most open wells, thereby making it unhygienic for direct consumption/drinking.

Bacterial may be indigenous or be spread by contaminated surface water (i.e. sewage effluent, leakage from garbage dumps, and other polluted bodies of water) to shallow ground water table. No matter what the source of bacteria is, they (bacteria) and their biological processes affect the quality of ground water. Although water may appear abundant in nature portable water for domestic use is limited. (Met Calf and Eddy, 1978).

Water must be free from organisms that are capable of causing diseases and from minerals and organic substances that could produce adverse physiological effect. Domestic/drinking water should be aesthetically acceptable. It should be free from turbidity, colour, odour and from taste. Drinking water should also have reasonable temperature. Water that meet these conditions is termed "portable". Meaning water that can be consumed in any desired amount without concern for adverse effects to health (Elendu, 2006). Domestic water is that water which can be used in private residences, apartment, establishment, houses e.t.c for drinking, bathing, lawn, sprinkling, sanitary and other purposes.

It has become very serious, the problem of refuse disposal at Kpakungu area, Minna Niger state. The refuse dump areas are not far from residential area. This definitely have some impact on the ground water quality over time. Ground water varies in purity depending on the geographical condition of the soil through which it flows. As it flows, it absorbs from the soil some of the soluble gases and salt (UNICEF, 2000).

This study is aimed at investigating the effect of urban refuse disposal in ground water quality in Kpakungu through open shallow wells for its physical, chemical (heavy metals) and bacteriological properties. The level of the properties compared with standard of World Health

Organization (WHO, 2007) and Nigeria Industrial Standard (NIS 554, 2007) recommended for domestic drinking water.

## 1.2 Statement of the Problem

In as much as hand-dug wells serve as the easiest and cheapest source of water supply to most rural areas, with Kpakungu as a case study, it is paramount to note that the water purity is not as it appears to be to the human sight as it is altered or impaired by the refuses dumped around the environment, whose decomposition dissipates into the soil and down to the underground water through percolation after rain fall.

## 1.3 Objective of the Study

- (i) To investigate the effect of refuse disposal on ground water quality in Kpakungu settlement.
- (ii) To access the physio-chemical, and bacteriological analysis of domesticated open shallow wells within the study site and comparing to WHO, 2007 and NIS 554, 2007 standards.
- (iii) To determine whether or not the affected open shallow wells in Kpakungu satisfies the WHO, 2007 and NIS 554, 2007 quality standard for the stated parameters.

## 1.4 Justification of the Study

The usage of shallow open well system is to obtain ground water as an alternative to pipe borne water supply in rural areas to supply water to household, irrigation, industries and so on. The use of it remains the most prevalent form of ground water, sourcing widely employed in areas where surface water is insufficient or rarely found especially during dry season

## 1.5 Scope of the Project

The frame work of this study is to investigate the effect of urban refuse disposal on ground water quality basically on open shallow wells in Kpakungu settlement and to access the physical, bacteriological and chemical (with emphasis on elements such as Zinc, Chromium and Manganese) contaminants through laboratory test and to determine impact of the effect of these contaminant on human health.

## 1.6 Limitation of the Study

The laboratory analysis is restricted to only three (3) elements (Zn, Cr and Mn) due to unavailability of reagent to carry out similar analysis on other heavy elements such as Pb, Ni and Cu.

## CHAPTER TWO

### 2. LITERATURE REVIEW

#### 2.1 Water Quality

In Nigeria 75 to 90% of population lives in the rural areas in which stream and dug well are their main source of drinking water (Ibrahim, 2004) where Kpakungu is an evidence of this report. During dry season surface water are rarely found, while ground water is the only available source.

As precipitation, water contains few impurities. Almost no bacteria content is present and only small amount of minerals and gases can be expected. Foreign substances can readily contaminate water. These pollutant can affect water's physical (mostly organic), chemical (mostly inorganic), biological characteristics. Both surface water and ground water are subject to pollution.

Water quality is closely linked to water use and to the state of economic development. The fact that an individual has a well that yields much water does not mean that he/she should just drink from it. Because water is such an excellent solvent it can contain lot of dissolved chemicals. Since ground water moves through rocks and subsurface soil, it has a lot of opportunity to dissolve substances as it moves. For that reason, ground water will often have more dissolve substance than surface water. Even though the ground is an excellent mechanism for filtering out particulate matter, such as leaves, soil and bugs, dissolved chemicals and gases can still occur in large enough concentration in ground water to cause problems.

Having a basic understanding about ground water quality will help ensure that your well is supplying portable water for your household. Along with human activities, water quality is affected by combination of natural processes.

### **2.1.1 Standards Followed**

Depending on the impact of concentration of various ions in water on human health and plants, various standards have been laid down by different agencies. These standards are useful for deciding the suitability of water for drinking and irrigation purposes. For the analysis being carried out in water quality laboratories the standards approved by World Health Organization (WHO, 2007) and Nigeria Industrial Standard (NIS 554, 2007) are shown in appendix A.

### **2.1.2 Physical Contaminants**

The most noticeable alteration of water quality fall within this category. The most common physical contaminant of water is suspended sediments, others include organic materials such as remains of plants and animals, inorganic materials such as celophane, bottles, tins, papers etc and plant residues. Most sediments occurs because of soil erosion. Turbidity is easy to see, and thus a likely source of dissatisfaction for the users. It is caused by the presence of suspended materials such as clay, silt, taste and odor can be caused by organic compounds, inorganic salts, or dissolved gases.

Formability is usually caused by concentration of detergents. The foam itself does not pose a serious health threat, but it may indicate that other s, more dangerous pollutants associated with domestic waste are also present.

### **2.1.3. Chemical Contaminants**

Groundwater is particularly subjected to chemical alteration, because as it moves downward from the surface it slowly dissolves some materials contained in rocks and soils. Chemicals are major source of water contaminants. Some of these chemicals occur naturally in water (Richman, 1997)

The domestic sewage composed of faeces from pit latrines, kitchen laundry waste are the major sources of pollution for the house hold wells. A chemical analysis is usually necessary for individual water supply sources. These will indicate

- (i) The possible presence of harmful or objectionable substances.
- (ii) The potential for corrosion within the water supply system.
- (iii) The tendency for the water to sustain fixtures and clothing.

#### **2.1.4. Bacteriological Contaminants**

Varieties of water borne disease are attributed to untreated or inadequate treated groundwater containing pathogenic forms of bacteria. Biological contamination of a ground water may occur when human or animal waste enters into an aquifer. Standard test to determine the safety of groundwater for drinking purposes involves identifying whether or not bacteria belonging to coli form group are present. The recent faecal pollution of water sources are indicated by the presence of coli form bacteria viz, *Escherichia coli*.

From the health point of view, the most important characteristics of good water is obviously the absence of pathogenic organisms. However, some of the individuals who pollute the water source may have diseases due to faecal organisms. Faeces of healthy as well as ill people contain millions of *Escherichia coli*.

#### **2.2. Source of Water Pollution**

Pollution has always been caused by man and animal in various activities. In developed world, domestic sewage, industrial sewage etc are treated as sewage works to reduce its toxicity and then discharged into rivers and streams having met the set standards e.g 20/30 standard i.e 20mg/l BOD and 30mg/l suspended solid (Singodoyin and Mson, 1997).



For high density housing it is usually to provide refuse dumps. Often these are merely convenient pieces of spare ground on the road side. Refuse is scattered by wind, goats, lunatics and children. After collection of the main mass of refuse some still remains as a breeding place for flies whose eggs and larvae penetrate the ground. When rain passes through it to the ground there is inevitable pollution floating solids are unsightly, organic matter exerts an  $O_2$  demand and pathogens can create a health danger down stream unless the water table is high.

Water pollution may originate from a point source or from dispersed source. A point source pollutant is one that reaches water from a single pipeline or channel or when harmful substances are emitted directly into a body of water (Terry, 1996), such as sewage discharge or out fall pipe. Disperse sources are broad, unconfined areas from which pollutants enter a body of water. Surface runoff from farms, for example, is a dispersed source of pollution, carrying animal wastes, fertilizers, pesticides, and silt into near by streams. Point source pollutant are easier to control than dispersed source pollutants. Since they flow to a single location where treatment process can remove them from the water. Such control is not usually possible over pollutants from dispersed sources. It is best reduced by enforcing proper land use plans and development standards. Types of water pollutant include pathogenic organisms. Inorganic chemicals, sediments etc. sewage is primary source of the first three types.

### **2.3. Chemical Examination of Water**

Chemical composition of water depends on the characteristics of the catchment. Ground water acquires the characteristics of the soil through which it flows. Common chemical pollutants which are of importance in water, are indicated in the table 2.3 shown in Appendix C. Reported (Samaila, 2004)

## **2.4. Groundwater Contamination from a Waste Disposal**

The physical property of an aquifer such as thickness, rock or sediment type and location to a large extent determines whether or not contaminants from land surface will reach the ground water. The risk of contamination is greater for unconfined (water table) aquifer than for confined aquifers because they usually are nearer or to the land surface and lack an overlying confining layer to impede the movement of contaminants.

### **2.4.1 Effect of Physical Contaminant to Groundwater Quality**

There are different types of impurities. These are organic chemicals, inorganic chemicals, turbidity etc. Organic contaminants include various pesticide, industrial solvent etc.

Turbidity refers to cloudiness by very small particles of silt, clay and other substances suspended in water. Even a slight turbidity in drinking water is objectionable to most people.

Colour, taste and odour are physical characteristics of drinking water that are important for aesthetic reason rather than for health reasons. Where high pH causes bitter taste; water using appliances become encrusted. Taste and odour may be caused by naturally occurring dissolved organics or gases. Some well water supplies, for example have a rotten egg odour caused by  $H_2S$ .

### **2.4.2 Effect of Bacteriological Contaminant to Groundwater Quality**

Coli form bacteria occur naturally in the environment from soils, plants, and in the intestine of humans and other warm blooded animals. Used as an indicator for the presence of pathogenic bacteria, viruses, and parasite from domestic waste.

## **2.5. Effect of Chemical (Heavy Metals) Contaminant to Groundwater Quality**

### **2.5.1 Effect of Manganese:**

Manganese can be a troublesome element in water, even when present in small quantities. It can be deposited in water in the presence of oxygen. Large quantity of manganese are toxic.

The concentration of manganese in solution rarely exceed 1.0mg per liter in a well aerated surface water. However, much higher concentrations can occur in ground waters subject to reducing conditions. The World Health Organization and the Nigeria Industrial Standard gives a guide level of 0.02mg per liter and a maximum admissible concentration of 0.2mg per liter (NIS 554, 2007), 0.5mg per liter (WHO, 2007).

These heavy metals are different chemically and so they cause different problems. Manganese causes dark brown or black stains on plumbing fixtures.

### 2.5.2 Effect of Zinc:

Found naturally in water. It occurs in source water and may be added to finished-water through corrosion of metal piece. Most frequently in areas with mines. It can enter into the environment from industrial waste, metal plating and plumbing.

Adverse health effects associated with zinc results more from too low an intake rather than from an excessive intake. The adult requirement for zinc is 15mg per day. Drinking water contributes about 3% of this requirement. The WHO 2007 guide level for zinc in drinking water is 3mg per liter. Maximum permissible limit is 15mg per liter. Heavy metal (Zn) standard is based on levels that cause human health problem, staining problem and taste. It is set under WHO, 2007 and NIS 554, 2007 drinking water standards. These standards set up for Zinc, is 3mgper liter.

This metal has negative effect on human health except manganese whose limit is only aesthetic objectives. Its presence in water can cause taste, economic damage and impacts brownish stains to laundry. While the others like zinc also impact an undesirable taste of water. Although effects associated with zinc result more from too low an intake rather than from an

excessive intake. But when taken in excess it causes muscular weakness and pain, irritability, and nausea. It also has undesirable taste effect on drinking water and health effect in excess. The level of zinc associated with these effects is 40mg per liter over a long period.

### 2.5.3 Effect of Chromium:

Chromium occurs in drinking water in its +3 and +6 valence states, +3 being more common. The valence is affected by the level of disinfection and presence of reducible organics. It can also enter the environment from old mining operations run-off and leaching into groundwater. The WHO, 2007 and NIS 554, 2007 standards for drinking water is 0.05mg per liter. Then, chromium III is nutritionally essential, non toxic and poorly absorbed. Chromium IV is much more toxic than chromium III, causes liver and kidney damage, internal hemorrhaging, respiratory damage, dermatitis and ulcers of the skin at high concentrations.

The longtime consumption of drinking water with high concentration of the heavy metals stated above can lead to problem or little trace of it might also have an effect .

### 2.6. Treatment Methods for Heavy Metals (Zn, Mn, Cr) Removal

There are number of technology available for the removal of heavy metals. Chemical precipitation is most commonly employed for most of the metals. Common precipitations include  $\text{OH}^-$ ,  $\text{CO}_3^{2-}$  and  $\text{S}^{2-}$ . Metals are precipitated as the hydroxide through the addition of lime amphoteric and exhibit a point of minimum solubility. The pH of minimum solubility varies with the metal in question. Metals can also be precipitated as the sulphide or in some cases as the carbonate. With precipitation and classification alone, effluent metal concentrations may be as high as 1 to 2mg per liter. Filtration could reduce these concentrations to 0.5mg per liter or less.

Metals can be removed by absorption or activated carbon, aluminium oxides, silica, clays and synthetic material such as Zeolites and resins. In the case of absorption, higher pH favors the absorption of cation while a lower pH favors the absorption of anion.

**2.6.1 Removal of Manganese:** Among the many forms and compounds of manganese only the manganous salts and the highly oxidized permanganate anion are appreciably soluble. The latter is a strong oxidant that is reduced under normal circumstances to insoluble manganese dioxide. The treatment techniques for its removal conversion of the soluble manganous ion to an insoluble precipitate. Removal is effected with oxidation of the manganous ion and separation of the resulting insoluble oxides and hydroxides. Manganous ion has a low reactivity with oxygen and simple aeration is not an effective technique below pH 9 (Alkaline). It has been reported that even at high pH levels, organic matter in solution can combine with manganese reduction by precipitation. The use of chemical oxidants to convert manganous ion to insoluble manganese dioxide in conjunction with coagulation and filtration has been employed.

**2.6.2 Removal of Zinc:** Zinc can be removed by precipitation as zinc hydroxide with either lime or caustic. The disadvantage of lime addition is the concurrent precipitation of calcium sulphate in the presence of high sulphate level in the water.

**2.6.3 Removal of Chromium:** The reducing agent commonly used for chromium wastes are ferrous sulphate, sodium meta-bisulphate, or sulphur dioxide. Ferrous sulphate and sodium meta-bisulphate may be dry or solution-fed,  $\text{SO}_2$  is diffused into the system directly from a gas cylinder. Since the reduction of chromium is most effective at acidic pH values, a reducing agent with acidic properties is desirable.

These heavy metal removal systems have the following disadvantages; They often require the use and handling of strong oxidants, they do not always produce a satisfactory

These heavy metal removal system have the following disadvantages; They often require the use and handling of strong oxidants, they do not always produce a satisfactory effluent quality and the filtration rate are limited. Making the equipment large and expensive (Samaila, 2004).

## CHAPTER THREE

### 3. MATERIALS AND METHOD

#### 3.1 Study Area

The study area, Kpakungu, is situated in South-West geographical zone of Minna, Niger state. It lies between longitude  $6^{\circ} 31' E - 6^{\circ} 32' E$  and latitude  $9^{\circ} 35' N - 9^{\circ} 36' N$ . Kpakungu falls within the Middle Belt of Nigeria (Southern Guinea Savanna). It has an average annual rainfall ranging between 1200mm and 1300mm, in August rainfall is at its peak. The range of temperature; varies from  $19.73^{\circ} C - 37.32^{\circ} C$  and the climate has excess humidity during greater part of the year. The months of February, March and April of every year, the area is at its peak of hotness, during this period the people of that area depends on underground water to sustain their life.

The dump sites are located close to the residential structures in Kpakungu, while pit latrine are inside the compounds and very close to the well about 1m away. Also, gutters are close to these wells. The wells studied are within this radius, these wells are very close to either the dump or latrine or gutters that the leach ate definitely impacts on the ground water overtime.

#### 3.2 Sample Size Determination

Three existing wells of less than 6m (19.69 ft) depth each locate at distance from well two (2). 2m, 120m; 150m from the dump sites were used as sampling points for ground water quality testing. For each well one (1) sample of the ground water was collected, analyzed ad

constituents present recorded. This was all the values recorded in the table were obtained. The analysis of water is the determination of the level of impurity in any given sample of water.

Three 1.5 liters plastic bottles were used to collect water samples. The plastic bottle was obtained as bottled water; the water was poured out in order to make use of the plastic bottle to collect the sample to avoid any other effect from the bottle. The sample from each well was first used to rinse the bottle before the main sample was collected. They were properly corked to prevent the water sample from being contaminated. In order to achieve a good result, they were labeled and the location of their collections were written and posted on the bottles. The water analysis was carried out at Federal Ministry of Agriculture & Water Resources (Water Sector) Regional Water Quality Laboratory, Minna.

### **3.3 Physical Analysis Procedure**

This analysis was carried out in order to determine the physical characteristics of the samples collected. The physical parameters used for the tests are as follows: colour, turbidity, temperature and odour. Odour was analyzed using subjective methods, this is one of the relative subjective methods.

#### **3.3.1 Turbidity Determination**

##### **Material / equipment used**

Sample vial, JMP turbidity meter

##### **Procedure for Turbidity**

Obtain a clean and dry sample vial and handle it by the top-rinse the vial with the sample, then fill with about 10ml of the sample capping the vial with a soft lint free cloth supplied and ensure outside the vial is free from smudges, clean and dry.



by pressing the ON/OFF key. After the power, sap sequence the display blanks (...Rd...) for about 12 sec. after which a value appears (turbidity value). In case of second vial, insert in the sample well and align the vials mark with the meter's index. Press the READ (ENTER KEY): the display links (...Rd...) and the value will appear, which the turbidity values is for other sample this steps is repeated.

### 3.3.2 Colour

Naturally, colour of any water tends to be yellow or brown and this is associated with an increase in turbidity. Shallow ground water and surface changes in colour is significantly due to contamination either due to rain or anthropogenic sources and this indicates the need for remedial action.

Monitoring colour may be through observation or by colour measurement using box or a spectrophotometer.

### 3.4 Chemical Analysis Procedure

The chemical analysis of this sample is cleared by the following parameters which were determined using appropriate methods. Manganese, zinc, chromium, chloride, total alkalinity and conductivity.

#### 3.4.1 Determination of Conductivity

**Method:** Conductivity is measured using the conductivity meter CMD 800hydro check conductivity meters.

#### Apparatus/Reagent

CMD 800hydro meter and cell.

#### Procedure for Conductivity

CMD 800hydro meter and cell.

### **Procedure for Conductivity**

Calibration: before meaningful and repeatable measurement of conductivity can be made, the setting or cell constant K and sample temperature must be made for specific conductivity at 25°C or at least known for cell absolute measurement. To view the cell constant K, switch on to MS (micro Siemens) by key A. Then, C+A (hold) - K will be displayed.

Making measurement: Switch on the key A, insert cell into test solution and reading will be display.

### **3.4.2 Determination of Alkalinity**

#### **Apparatus/Reagent**

H<sub>2</sub>SO<sub>4</sub>, Bromcresol green indicator, 250ml beaker

#### **Procedure for Alkalinity**

Measure out 100ml of the sample into a 250ml beaker and titrate using 0.02N H<sub>2</sub>SO<sub>4</sub>. Put three to four (3-4) drops of bromcresol green indicator and titrate till the colour changes from green to yellow.

### **3.4.3 Determination of Chromium**

#### **Colorimetric Method**

#### **Apparatus/Reagent**

Stock chromium solution, metric acid, (concentrated HNO<sub>3</sub>), Diphenylcarbazide solution, 125ml Erlenmeyer flask.

#### **Procedure for Chromium**

Pipette 25ml of the sample or standard into a 125ml Erlenmeyer flask  
Add 1-2 drop HNO<sub>3</sub> to each of the samples. PH should be 1+ 03

Add 0.50ml diphenylcarbazide to each sample using automatic pipet. Allow 5 to 10 minute for full colour development.

### 3.4.4 Determination of Chloride

Argentometric method

#### Apparatus/Reagent

Potassium chromate indicator ( $K_2CrO_4$ ), standard silver nitrate titrant ( $AgNO_3$ ),

#### Procedure for Chloride

Use a 100ml sample or a suitable portion diluted to 100ml. If the sample is highly coloured, add 3ml  $Al(OH)_3$  suspension, mix, let settle, and filter. If this sulfates sulfide or sulfite is present, add 1ml  $H_2O_2$  and stir for one (1) minute.

Add 1.0ml  $K_2CrO_4$  indicator solution. Titrate with standard  $AgNO_3$  titrant to a pinkis yellow and point be consistent in end – point recognition.

### 3.4.5 Determination of Zinc

Spectrophotometer method of analysis was used

#### Apparatus/Reagent

Spectrophotometer, sample cell, zincover (v) pillow, cyclohexane

#### Procedure for Zinc

Fill a 25ml sample cell with 20ml of sample after rinsing glass with 1:1 hydrochloric acid and deionized water. Add the contents of one zincover five reagent powder pillow. Cap, invert several times to completely dissolve the powder (Powder must be completely dissolved or inconsistent result may occur).

Measure 10ml of the orange solution into another sample cell (which the is the blank) add 0.5ml of cyclohexane one to the remaining orange solution in the first sample cell (the prepared

sample). Tightly cap the cell, shake vigorously for 30 seconds (the prepared cell). A three (3) minute reaction will begin, place the blank into the cell holder. Tightly cover the sample cell with the instrument cap. It will read zero (0). Immediately place the prepared sample into the cell holder. Tightly cover the sample cell with the instrument cap, and then read result. This will be done also for the other two samples.

### 3.4.6 Determination of Iron

Phenanthroline method

#### Apparatus / Reagents

Concentrated HCl, containing less than  $5\% \times 10^{-6}$  iron

Hydroxylamine hydrochloric solution

NH<sub>2</sub>OH HCl in 100ml water, 125ml Erlenmeyer flask, volumetric flask.

#### Procedure for Iron

- a. Mix the sample thoroughly and measure 50.0ml into a 125ml Erlenmeyer flask. If this sample contains more than 200mg iron use a smaller accurately measured portion and dilute to 50ml and add 2ml of concentrated HCl and 1ml of hydroxylamine hydrochloride solution.
- b. Drop in a few glass beads and boil until the volume is reduced to 10-20ml. cool to room temperature.
- c. Transfer to a 50ml or 100ml volumetric flask adds 10ml ammonium acetate buffer solution and 2ml of phenanthroline solution, and dilution to the mark with distilled water. Mix thorough and set aside for 10-15 minutes for full colour development.
- d. Measure the colour intensity photometric at 510mm. Subtract the absorbance of the blank from that of the sample to determine the net absorbance.

### 3.4.7 Determination of Manganese

Colorimetric Method

#### Apparatus/Reagent

Colorimetric meter, test tube, manganese number 1 and 2 tablets

#### Procedure for Manganese

Fill test tube to 10ml mark.

Add one manganese No.1 tablet crush and mix to dissolve.

Add one manganese No.2 tablet crush and mix to dissolve, cap the tube.

Stand for exactly 20 minutes at 20°C

Take the test reading.

The result of the chemical analyses are shown in the table below:

### 3.5 Biological Analysis Procedure

The biological analysis was done in order to determine the coliform count and the total bacteria count. Test for Coliform bacteria and *Escherichia coli* are the most important routine microbiological examinations carry out on drinking water. They provide the most sensitive means for detecting faecal contamination for assessing the effectiveness of water treatment and disinfection and for monitoring water quality in distribution. In the context of this method, organizations which oxidase negative, produce acid from lactose and form all shades and sizes of yellow colonies on membrane filter (after incubation for 4 hours at 30°C followed by 14hrs at 37°C) are regarded as Coliform bacteria which possess beta-galactosidase. The *E. coli* (oxidase negative) produces acid from lactose and indole from tryptophan, and from all shades and sizes

of yellow colonies on membrane filter (after incubation for 4 hrs at 30°C followed by hrs 37°C or 44°C). Both Coliform bacteria and E.coli have been regarded as members of the family Enterobacteriaceae. Most strains of E.coli produce beta-glucuronidase enzyme.

### Method

Membrane filtered method.

### Apparatus/Reagents

Membrane filtration apparatus, incubators (far assisted either static temperature or temperature cycling)-capable of maintaining temperature of  $30 \pm 1.0^\circ\text{C}$ ,  $37 \pm 1.0^\circ\text{C}$  and  $44 \pm 0.5^\circ\text{C}$ , or cyclical incubators fitted with timers, capable of maintaining these temperatures.

-filtration apparatus, sterile or sterilisable filter funnel and vacuum source.

-smooth tipped forceps, water baths (or incubators) set at  $7.0 \pm 0.5$ , or  $44.0 \pm 0.5$  and test tube racks, membrane lauryl sulphate broth.

Peptone 40g, yeast extract 6g, lactose 30g, phenol red (0.4% m/v aqueous solution) 50ml, sodium lauryl sulphate-specially pure 1g, distilled deionized or similar grade water 1 litre.

### Analytical Procedure

**Sample Processing:** Place an absorbent pad into each of the two sterile petri dishes.

Aseptically, add sufficient membrane lauryl sulphate broth to saturate the pad. Allow the medium to soak into the pad and pour off and discard my excess medium. Confluent growth may result if not done. Place the disinfected filtration apparatus in position and connect to a source of vacuum with the stop cork turned off. Remove the funnel and holding the edge of the membrane filter with sterile smooth-tip forceps; place sterile membrane filter, grid side upwards, unto the porous disk of the filter base. Replace the sterile funnel securely on the filter base. Pour of pupette the require volume of sample into the funnel. When the volume of sample to be filtered is less than

10ml add 10 to 20ml of sterile diluents (e.g. quarter strength ringer's solution or maximum recovery diluents) to the funnel before addition of the sample. This eases the dispersion of the bacteria over the entire surface of the membrane filter during the filtration process. Open the stop cock and apply a vacuum not exceeding 65kpa (500mm of mercury) and filter the sample slowly through the membrane filter. Close the stop cock as soon as the sample has been filtered so that as little air as possible is drawn through the membrane filter. Remove the funnel and transfer the membrane filter car to one of the pads saturated with membrane lauryl sulphate broth. Ensure that no air bubbles attract bet the membrane filter and medium. Repeat the process with the second volume of water.

When the funnel is removed, it can be placed in a boiling water bath containing boiling distilled, deionized or similar grade water for one minute (if the funnel is to be reduced). The Petri dishes inverted and placed in an incubator at 30°C for 4hrs. One dish is then transferred to an incubator at 37°C 14hrs (for Coliform bacteria) and the other dish to an incubator at 44°C for 14hrs (for E.coli). alternative cyclical temperature incubators can be used. After the total incubation period of 18hrs, examine the membrane filter under good light, if necessary with a hand lens (colour are liable to change on cooling standing). Hence, within 15minutes of being removed from incubator, count all yellow colonies (however faint) irrespective of size. The number of colonies counted on the membrane filter incubated at 37°C is regarded as the number of presumptive Coliform bacteria and the number of colonies counted on the membrane filter incubated at 44°C is regarded as the number of presumptive Escherichia coli.

### 3.6 Health Implication

As a result of the high levels of chemical and biological contaminations of water from the shallow wells, health problems are imminent when such water is consumed without treatment.



## CHAPTER FOUR

### 4. RESULTS AND DISCUSSION

#### 4.1 Presentation of Results

The result of the physio-chemical analysis was obtained from federal ministry of agriculture and water resources (water sector ); Regional water quality laboratory, Minna. It is shown in table 4.1

#### 4.2 Discussion of Results

The results shown in the tables were obtained from the physical chemical and biological analysis of water sample.

Appendix A shows the World Health Organization's (WHO, 2007) Nigeria Industrial Standard (NIS 554: 2007) recommended concentration/standard range for water quality parameters. This is a guide for ascertaining the quality of water for industrial and domestic use. In preparing the table of parameters and maximum permitted limits. Care has been taken to ensure that flexibility is carefully managed and balanced taking into consideration. Water system economic viability without unduly compromising the health of the consumers.

Table 4.1, 4.2 and 4.3 shows the parameters of the sample one (1) two(2) and three (3) tested most of the physical parameters were found not to be within acceptable limits (except odour) as recommended by world health organization and Nigeria industrial standard shown in Appendix A.

The chemical parameters most of it were found to be within acceptable limits except for few (e.g. Iron in table 4.1, Mn in table 4. 3, also temp in all the tables) as recommended in both standards, WHO and NIS 554 in this chemical characteristics, positive variance in Ph value is not good enough, because it tends to make the water more acidic than it ought to be whereas,

The biological characteristics of the samples tested and recorded. The total coliform count (indication of faecal contamination) and E.coli are high for all the samples from the well. The wells are 2m, 120m, 150m away from the dump site i.e. the biological characteristic is far above the World Health Organization's and Nigeria industrial standard. Therefore, this well water are contaminated and not fit for consumption, because it has effect on human health.

# FEDERAL MINISTRY OF AGRICULTURE & WATER RESOURCES (WATER SECTOR)

REGIONAL WATER QUALITY LABORATORY, MINNA

OFFICE:  
Km 5 Zungeru Road,  
River Basin Estate,  
P.M.B 137 Minna,  
Niger State.



Tel: 066-224178  
Fax: 066-224178  
Our Ref:.....  
Your Ref:.....

TABLE 4.1 RESULT OF PHYSICO-CHEMICAL ANALYSIS

Parameter	Unit	Measured Valve 1	2	3	WHO GUIDE 2007	NIS 554:2007 MAXIMUM PERMITTED LEVELS
Temperature	°C	28.8	28.7	28.6	25	Ambient
pH	-	6.81	6.96	6.54	6.5-8.5	6.5-8.5
Conductivity	µS/cm	1039	1362	1075	10-1000	10-1000
Colour	TCU	337	371	324	15	15
TDS	Mg/L	696.13	912.5	720.2	1000	500
Turbidity	NTU	16.13	2.24	5.44	5	5
DO <sub>2</sub>	Mg/L	4.68	5.55	4.77	7.5	-
Suspended Solid	Mg/L	14	0	0	-	-
Flouride	Mg/L	0.01	0.49	0.22	1.5	1.0
Chloride	Mg/L	150.95	143.4	145.9	250	250
T Hardness	Mg/L	150	193	153	100	150
Cal Hardness	Mg/L	125	121	122	-	150
Mg Hardness	Mg/L	25	72	31	-	-
Ca <sup>2+</sup>	Mg/L	50.1	48.49	48.89	-	-
Chromium	Mg/L	0.00043	0.000	0.000	0.05	0.05
Mg <sup>2+</sup>	Mg/L	6.1	17.56	7.56	-	-
Alkalinity	Mg/L	121	293	104	200	-
CO <sub>3</sub>	Mg/L	0	0	0	-	-
Sodium	Mg/L	75.04	61.50	59	200	200
Potassium	Mg/L	23.45	65.66	22.78	-	-
Ammonia	Mg/L	1.80	1.30	2.60	-	-
HCO <sub>3</sub> <sup>-</sup>	Mg/L	121	293	104	-	-
Manganese	Mg/L	0.022	0.07	0.106	0.2	0.05
Iron	Mg/L	0.85	0.08	0.13	0.3	0.3
Zinc	Mg/L	0.04	0.07	0.11	3	5
Nitrate	Mg/L	7.97	5.75	11.51	50	10
Hydroxide	Mg/L	0	0	0	-	-
Total Coliform	Cfu/ML	204	160	75	0	10
E-Coli	Cfu/100 ML	4	3	15	0	0

JAMILU HABU  
LABORATORY MANAGER

REGIONAL WATER QUALITY  
LAB. MINNA  
MICROBIOLOGY LAB.  
SIGN: [Signature]  
DATE: 10-12-2015

Table 4.2: Variance for Water Sample 1

Parameters	Unit	WHO standard Variance	Remark	NIS 554 Variance	Remark
Temperature	°C	-3.8	Not ok	-3.8	Not ok
p <sup>H</sup>	-	-	-	-	-
Dissolved oxygen	Mg/L	-	-	-	-
Conductivity	Ns/cm	+1461	ok	-39	Not ok
Total dissolved solid	Mg/L	+303.87	ok	-196.13	Not ok
Turbidity	NTU	-11.13	Not ok	-11.13	Not ok
Suspended solid	Mg/L	-	-	-	-
Colour	TCU	-332	Not ok	-332	Not ok
Fluoride	Mg/L	+1.49	ok	+1.49	Ok
Sodium	Mg/L	+124.96	ok	+124.96	Ok
Potassium	Mg/L	-	-	-	-
Nitrite	Mg/L	+9.985	ok	+49.985	Ok
Nitrate	Mg/L	-6.97	Not ok	-7.77	Not ok
Ammonia	Mg/L	-1.3	Not ok	-	-
Iron	Mg/L	-0.55	Not ok	-0.55	Not ok
Manganese	Mg/L	+0.478	ok	+0.178	Ok
Zinc	Mg/L	+2.96	ok	+2.96	Ok
Chromium	Mg/L	+0.04957	ok	+0.04957	Ok
Calcium 10n	Mg/L	+24.9	ok	+24.9	Ok
Magnesium 10n	Mg/L	-5.9	Not ok	-5.9	Not ok
Bicarbonate (HC <sup>03</sup> )	Mg/L	-	-	-	-
Carbonate (C03 <sup>2-</sup> )	Mg/L	-	-	-	-
Chloride	Mg/L	+99.05	Ok	+99.05	Ok
Alkalinity	Mg/L	+79	Ok	-	-
Odour	Mg/L	+3	Ok	-	-
Hydroxide	Mg/L	-	-	-	-
Total coliform	Cfu/100ml	-204	Not ok	-194	Not ok
E-coli	Cfu/100ml	-4	Not ok	-4	Not ok
Total hardness	Mg/L	-50	Not ok	-	-
Calcium hardness	Mg/L	-	-	+25	Ok
Magnesium hardness	Mg/L	-	-	-	-

Table 4.3: Variance for Water Sample 2

Parameters	Unit	WHO standard Variance	Remark	NIS 554 Variance	Remark
Temperature	°C	-3.7	Not ok	-3.7	Not ok
p <sup>H</sup>	-	-	-	-	-
Dissolved oxygen	Mg/L	-	-	-	-
Conductivity	Ns/cm	+1138	Ok	-362	Not ok
Total dissolved solid	Mg/L	+87.46	Ok	-412.54	Not ok
Turbidity	NTU	+2.76	Ok	+2.76	Ok
Suspended solid	Mg/L	-	-	-	-
Colour	TCU	-356	Not ok	-356	Not ok
Fluoride	Mg/L	+1.01	Ok	+1.01	Ok
Sodium	Mg/L	+138.5	Ok	+138.5	Ok
Potassium	Mg/L	-	-	-	-
Nitrite	Mg/L	+9.18	Ok	+59.18	Ok
Nitrate	Mg/L	-4.755	Not ok	-5.555	Not ok
Ammonia	Mg/L	-0.8	Not ok	-	-
Iron	Mg/L	+0.22	Ok	+0.22	Ok
Manganese	Mg/L	+0.43	Ok	+0.13	Ok
Zinc	Mg/L	+2.93	Ok	+2.93	Ok
Chromium	Mg/L	+0.04957	Ok	+0.04957	Ok
Calcium 10n	Mg/L	+26.504	Ok	+26.504	Ok
Magnesium 10n	Mg/L	-17.368	Not ok	-17.368	Not ok
Bicarbonate (HC <sup>03</sup> )	Mg/L	-	-	-	-
Carbonate (C03 <sup>2-</sup> )	Mg/L	-	-	-	-
Chloride	Mg/L	+106.55	Ok	+106.55	Ok
Alkalinity	Mg/L	-93	Not ok	-	-
Odour	Mg/L	+3	Ok	-	-
Hydroxide	Mg/L	-	-	-	-
Total coliform	Cfu/100ml	-160	Not ok	-150	Not ok
E-coli	Cfu/100ml	-3	Not ok	-3	Not ok
Total hardness	Mg/L	-93	Not ok	-	-
Calcium hardness	Mg/L	-	-	+78	Ok
Magnesium hardness	Mg/L	-	-	-	-

**Table 4.4: Variance for Water Sample 3**

Parameters	Unit	WHO standard Variance	Remark	NIS 554 Variance	Remark
Temperature	°C	-3.6	Not ok	-3.6	Not ok
pH	-	-	-	-	-
Dissolved oxygen	Mg/L	-	-	-	-
Conductivity	Ns/cm	+1425	Ok	-75	Not ok
Total dissolved solid	Mg/L	+279.75	Ok	-220.25	Not ok
Turbidity	NTU	-0.44	Not ok	-0.44	Not ok
Suspended solid	Mg/L	-	-	-	-
Colour	TCU	-309	Not ok	-309	Not ok
Fluoride	Mg/L	+1.28	Ok	+1.28	Ok
Sodium	Mg/L	+141	Ok	+141	Ok
Potassium	Mg/L	+9.18	Ok	+49.18	Ok
Nitrite	Mg/L	-	-	-	-
Nitrate	Mg/L	-10.51	Not ok	-11.31	Not ok
Ammonia	Mg/L	-2.1	Not ok	-	-
Iron	Mg/L	+0.17	Ok	+0.17	Ok
Manganese	Mg/L	+0.394	Ok	+0.094	Ok
Zinc	Mg/L	+2.89	Ok	+2.89	Ok
Chromium	Mg/L	+0.04986	Ok	+0.04986	Ok
Calcium 10n	Mg/L	+26.11	Ok	+26.11	Ok
Magnesium 10n	Mg/L	-7.36	Not ok	-7.36	Not ok
Bicarbonate (HC <sup>0</sup> 3)	Mg/L	-	-	-	-
Carbonate (C03 <sup>2-</sup> )	Mg/L	-	-	-	-
Chloride	Mg/L	+104.05	Ok	+104.05	Ok
Alkalinity	Mg/L	+96	Ok	-	-
Odour	Mg/L	+3	Ok	-	-
Hydroxide	Mg/L	-	-	-	-
Total coliform	Cfu/100ml	-75	Not ok	-65	Not ok
E-coli	Cfu/100ml	-15	Not ok	-15	Not ok
Total hardness	Mg/L	-53	Not ok	-	-
Calcium hardness	Mg/L	-	-	+28	Ok
Magnesium hardness	Mg/L	-	-	-	-

## CHAPTER FIVE

### 5. CONCLUSIONS AND RECOMMENDATIONS

#### 5.1 Conclusions

The study of this area has revealed that the concentration of waste materials pit latrine and gutters close to or within residential areas systematically pollutes ground water over time.

Clearly, the problems associated with water pollutions have the capabilities to disrupt life to great extent. The government should try to combat water pollution thus acknowledge the fact that water pollution is indeed, a serious issue. But the government alone cannot solve the entire problem. It is ultimately up to the people, to be informed, responsible and involved when it comes to the problem they face with their water. They must become familiar with their local water resources and learn about ways for disposing house hold wastes. Where to dig their wells, i.e. distance of well from gutters and latrines. Around the houses, they should keep litter, pet waste, leaves and grasses clippings out of gutters and storm drains. The people have the ability to combat water pollution.

#### 5.2 Recommendations

It is found that the water is polluted physically and biologically. Pollution of the well depends on the nature of the well i.e. nearness to waste, dept of well, type of construction and fetching pale. Awareness and education will most assuredly continue to be the two most important ways to prevent water pollution.

Land disposal is the most common management strategy for municipal solid waste. Refuse can be safely deposited in a sanitary land fill a disposal site that is carefully selected, designed, constructed and operated to protect the environment and public health. One of the most important factors relating to land fill is that the buried waste never comes in contact with surface

water or ground water. Engineering design requirements include a minimum distance between the bottom of the land fill and the seasonally high ground water. Most new kind fills are required to have an impermeable liner or barrier at the bottom, as well as a system of ground water monitoring wells. Completed kind fill sections also must be capped with an impermeable cover to keep precipitation of surface away from the buried waste.

A good type of communal refuse container is made in Lagos. It is a covered metal box which can hold about ten (10) cubic metres of refuse. Sliding panels enable the container to be completely close after refuse has been dumped. The container is removed by a special vehicle which brings an empty cleaned replacement container. Smaller covered containers are locally made by Nairobi and are emptied into refuse collection vehicles using a purpose made lifting device on the side.

The principle of controlled tipping is that layers of refuse are compacted and covered by a layer of inert material. Americans call it "sanitary land fill". To allow for proper disposal.

### **Protection of Wells**

1. Well should of deep
2. The sides of the well should be lined with impervious material to a dept of about three meters to prevent the entering of the water flowing near the ground.
3. An area within 15 meters of the well should be kept free from pollution. In this area, there should be no any pit latrines, soak a ways or cesspits should be relocated and refuse dump should be minimum of 200 meters away.

Local government should designate sacrifice area where all forms of waste are to be dumped.

License should be issued and renewed for permission to dump waste and sacrificed area.



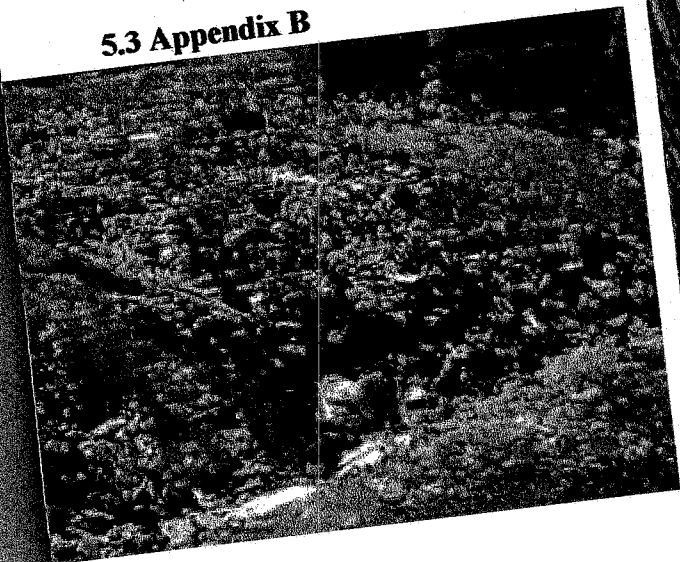
## REFERENCES

- Duncan Mara, Michael Mc. Garry & Richard Feacher, Water Wastes and Health in hot climates, 1986, A. Wiley pp. 163-173
- MacDonnell, L.J. Water Land Water Law Rcv., Vol. 31. no. 2 Pp. 329-348, 1996.
- Michael, T.P. Ojha, Principles of Agricultural Engineering Vol. II. Surveying \* Irrigation \* Drainage Soil & water conservation, 2006 New Dehi. Pp. 169-181.
- Richman M. IND. Renee Water Pollution Waste Water, Vol. 5, no. 2 Pp. 24-29, 1997.
- Terry, L.A. Water Pollution Environ. Law Pract., Vol. 4, no.1, Pp. 19-29, 1996
- Williams J. Guiness / John S. Reynolds / Benjamin Stein, Mechanical & Electrical Equipment for building, 7<sup>th</sup> Edition, Vol. 1, Pp. 499-507.

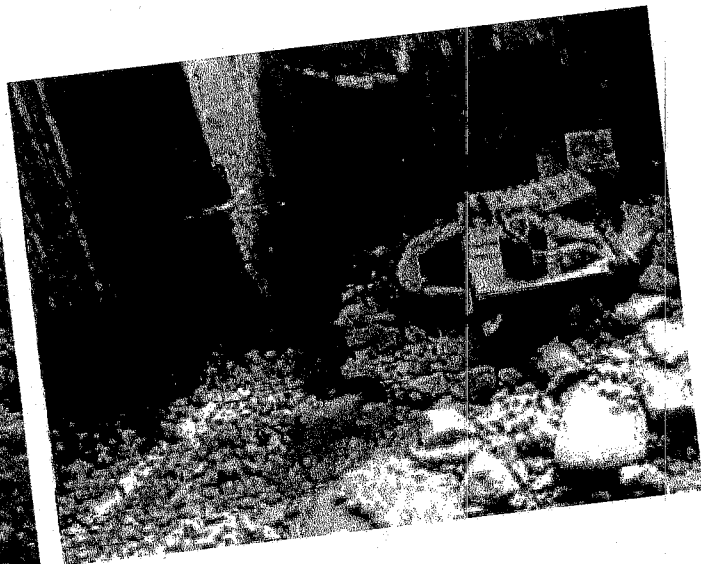
5.2 Appendix A

Parameters	Unit	WHO, standard	1994	NIS standard	554, 2007
Temperature	<sup>0</sup> C	25		Ambient	
p <sup>H</sup>	-	6.5-8.5		6.5-8.5	
Dissolved oxygen	Mg/L	-		-	
Conductivity	Ns/cm	2500		1000	
Total dissolved solid	Mg/L	1000		500	
Turbidity	NTU	5		5	
Suspended solid	Mg/L	-		-	
Colour	TCU	15		15	
Fluoride	Mg/L	1.5		1.5	
Sodium	Mg/L	200		200	
Potassium	Mg/L	-		-	
Nitrite	Mg/L	10		50	
Nitrate	Mg/L	1		0.2	
Ammonia	Mg/L	-		-	
Iron	Mg/L	0.3		0.3	
Manganese	Mg/L	0.5		0.2	
Zinc	Mg/L	3		3	
Chromium	Mg/L	0.05		0.05	
Calcium 10n	Mg/L	75		75	
Magnesium 10n	Mg/L	30		0.2	
Bicarbonate (HC <sup>0</sup> 3)	Mg/L	-		-	
Carbonate (C03 <sup>2-</sup> )	Mg/L	-		-	
Chloride	Mg/L	250		250	
Alkalinity	Mg/L	200		-	
Odour	Mg/L	3		Unobjectionable	
Hydroxide	Mg/L	-		-	
Total coliform	Cfu/100ml	0		10	
E-coli	Cfu/100ml	0		0	
Total hardness	Mg/L	100		-	
Calcium hardness	Mg/L	-		150	
Magnesium hardness	Mg/L	-		-	

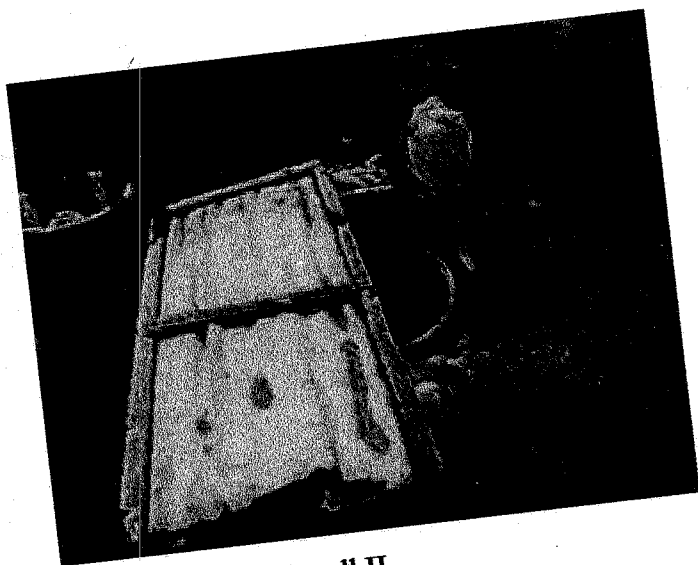
**5.3 Appendix B**



**Plate 3.1 Refuse Dump site**



**Plate 3.2 Affected Well I**



**Plate 3.3 Affected well II**

Appendix C

Table 2.3

Water Chemical Pollutants

Pollutants	Pollutant	Pollutant
Calcium (Ca <sup>++</sup> )	Dissolved Salt (anion)	Alkalinity, Acidity
Magnesium (Mg <sup>++</sup> )	“	Hardness
Iron (Fe <sup>++</sup> )	“	Hardness, Color, Taste
Zinc (Zn <sup>++</sup> )	“	Taste
Bicarbonate (HCO <sub>3</sub> )	Dissolved Salt (cation)	Hardness, color
Carbonate (CO <sub>3</sub> <sup>-</sup> )	“	Alkalinity
Sulphate (SO <sub>4</sub> <sup>-</sup> )	“	“
Chloride (Cl)	“	Lascative
Flouride (F)	”	Taste
Organics	“	Tooth motting color
Gases O <sub>2</sub>	Dissolved gases	Corrosion, Oxidation
CO <sub>2</sub>	“	Acidity
H <sub>2</sub> S	“	Acidity, Reducing agent

Source: A Kastalsky, 1989.