EFFECT OF AUTOMOBILE EFFLUENTS ON GROUNDWATER QUALITY

(A CASE STUDY OF KETEREN-GWARI AUTOMOBILE REPAIR SITE, MINNA, NIGER STATE)

BY

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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 Information derived from communications, published and unpublished work were duly referenced in the text.

18TH FEBRUARY 2010.

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CERTIFICATION

This project entitled "Effect of Automobile Effluents on Groundwater Quality (A Case Study of Keteren-Gwari Automobile Repair Site, Minna, Niger State)" by Upaa Kinga Michael, 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.

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DEDICATION

This project is dedicated to my ever supportive parents Hon & Mrs C.T.K Upaa for all their love and support throughout my stay in the university

ACKNOWLEDGEMENTS

All praise and honour be to God Almighty through His son Jesus Christ, the Author and the Finisher of my faith, for keeping me alive and healthy throughout my stay in the university and all through my entire live. So many people have been instrumental at one point or the other in the course of my studies. Worthy of note are my parents, Hon & Mrs C.T.K Upaa, my siblings, Tersoo, Member, Doofan and Sesugh, my brother's wife Mrs Aka Upaa, my cousin Jerry Aondo, and my uncle, Elvis Aondo, I would never have done it without their love, support and prayers.

I also want to use this medium to appreciate the support of my Project Supervisor Mr. Mohammed Sadeeq, I would also like to thank Engr. S.M. Dauda for his support, he was like an elder brother to me during my years in the university and also the entire lecturers in Agricultural and Bioresources Engineering, for their various contributions to the successful completion of my course in the University.

Lastly my gratitude goes to all my course mate and friends, worthy of note are, Gali Solomon, Idim Bassey, Ismaila Ismaila, Akpan jude, Emuoke Ochuko, Nwagbala Francis, Odion Finnan, Maduka Chijoke, Ukaa Tertsegh, Lyam Jacob, Kpojime Harold, Ikyator Sefa, Adoor Simon (R.I.P) and all those not mentioned that have positively impacted my life during the course of my stay in the university and life in general. Thanks a lot guys.

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ABSTRACT

Water samples from five groundwater sources i.e one borehole and four open wells within Keteren-gwari automobile repair site, Minna, Niger State were analysed to determine the effect of automobile effluents on groundwater quality in the area. Turbidity as well as the heavy metals (Ar, Cu, Ni and Pb) were at infinitesimal levels and could not be detected by the test means used during the analysis. The range of the remaining parameters tested for in the five samples i.e, pH (6.5-6.8), total hardness (11.6-13.4 mg/l), conductivity (210-300 μs/cm), sulphate (118-122 mg/l), nitrate (0.12-0.18 mg/l), Cd (0.00-0.02 mg/l), Cr (0.00-0.02 mg/l), Fe (0.23-0.28 mg/l), Zn (0-2 mg/l), and Mn (0.1mg/l) were all within safe limits of the World Health Organization (WHO) standard of pH (6.5-8.5), total hardness (100 mg/l), sulphate (200 mg/l), nitrate (50 mg/l), Cd (0.03 mg/l), Cr (0.05 mg/l), Fe (0.05-0.3 mg/l), Zn (5.0 mg/l), and Mn (0.5 mg/l) for drinking water and water meant for domestic use. It was also observed that water obtained from the borehole source had the least amount of contaminants detected in relation to that obtained from open wells therefore would be a better source of water for drinking and domestic use. Overall, consumption of water from the groundwater sources analysed in this study would not pose any significant health problems as at the time of this study.

CHAPTER ONE

1.0 INTRODUCTION

1.1 The World's Hidden Water Resource

Most of the earth's liquid fresh water is found not in lakes and rivers, but is stored underground in the aquifers (Young, 1992). Indeed these aquifers provide valuable base-flow supplying water to rivers during periods of no rainfall. They are therefore, an essential resource that requires protection so that groundwater can continue to sustain the human race and the various eco-systems that depend on it. The contribution from ground water is vital; perhaps as many as two billion people worldwide depend directly upon aquifers for drinking water, and 40% of the world's food is produced by irrigated agriculture that relies largely on ground water. In the future, aquifer development will continue to be fundamental to economic development and reliable water supplies will be needed for domestic, industrial and irrigation purposes.

Yet recognition of the pivotal role of ground water in human development is relatively recent and still patchy. The omission is understandable, water stored in the ground beneath our feet is invisible and so it's depletion or degradation due to contamination can proceed unnoticed, unlike our rivers, lakes, reservoirs, where drying up or pollution rapidly becomes obvious and is reported. Thus we must determine which environmental process within the aquifer system can help to mitigate contamination, which environmental setting is more vulnerable, and how the resources can be managed to conserve them for future use. One of the characteristics of ground water is that polluting usually takes a very long time to appear in a water source, often decades or longer. In consequence, it is technically difficult and expensive to clean up an aquifer once it is polluted (WHO, 1998).

1.2 Ground Water Pollution

No matter where we live, we can be sure that groundwater pollution is a problem for humanity. The myth that ground water sources in rural areas are safer than the urban area is completely false. Sampat, (2000) reported that ground water pollution is epidemic, and almost all the contaminants that reach water sources are caused by the actions or inactions of people, everything from agricultural sources to industrial sources contributes to the ground water pollution problem.

Groundwater pollution is such a serious problem because the tainted water puts everyone at risk for potential health problems. The level of contamination and the vast variations of the contamination make it nearly impossible to determine the exact potential for health threats. While some contaminants cause very obvious health problems, many of the pollutants have an unknown effect on the health of the human body (UNEP, 1996).

Residential contamination is not the only cause of the pollution of groundwater. While industrial regulations help to prevent excessive pollution, the smaller businesses are not monitored as closely. Auto mechanics and repair shops are almost always in constant violation. Because these businesses are smaller, they end up not being as closely monitored for pollutant contributions. Antifreeze, waste oil, and deicer can cause significant and dangerous pollution levels in the ground water. Some of the biggest contributors to the industrial pollution problem include small auto mechanic businesses that often run their businesses from property close to residential areas (U.S. EPA, 1994).

1.3 Groundwater Contamination by Automobile Waste.

It is important to device means to protect groundwater from pollution by the underground discharge of fluids. The potential risk of groundwater contamination by activities of auto-repair sites can be very high. Often the types of waste fluids that are used to clean parts, used motor oil, coolant and other fluids, can be characterized as hazardous and/or dangerous waste. The waste fluids and other wastes, if washed down a drain and in to a motor vehicle waste disposal well, could pose a serious risk to human health if ground water were to be contaminated. When these compounds enter the ground water, the public can be exposed in variety of ways. The most serious risk of exposure is through the consumption of contaminated ground water.

1.4 Justification of the Study

The significance of groundwater studies cannot be overemphasized, since water is very necessary for all forms of life in the eco-system. The various activities of man over the years have sometimes tended to cause serious harmful effects to ground water reservoirs. With man's ever increasing dependence on ground water such pollutions could be of detrimental to the short and long term health of man. Hence, the outcome of this study will be beneficial in determining the effects that activities of auto-mechanic repair sites located near residential areas could have on groundwater sources, and the health risks associated.

1.5 Statement of the Problem

As surface water becomes increasingly polluted, people turn to groundwater for alternative supplies. But with increasing human activities and deposition of harmful waste on the soil which gradually leaches in to ground water sources, groundwater is also susceptible to pollution over time. Therefore the development and efficient management of groundwater resources has become of great significance especially in the northern part of Nigeria. In these areas, not only is there relative scarcity of water resources and quality degradation but also they face high evaporation rates and high level of anticipated future demands, making groundwater quality conservation more or less highly imperative.

1.6 Aims and Objectives of the Study

- To assess the quality of ground water from wells and boreholes located within Ketern-Gwari auto-mechanic repair site, Minna.
- To determine the effect of automobile effluents on the groundwater quality within the study area.

1.7 Scope of the Study

The study of groundwater quality is very important so as to check the health risks posed by the actions or inactions of man on this enormous resource. The scope of this study includes;

- Collection of water samples from groundwater sources i.e. well/bore-hole, within Ketern-Gwari auto-mechanic repair site
- Analysis of the samples collected from the site
- Comparing the results of the analyzed samples to WHO standards for potable water, in order to determine the impact that the auto-mechanic site has on the groundwater quality in the area

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 General Background of study

Nigeria with a land area of approximately 950,000km sq. is richly endowed with diverse resources, however, there are staggering environmental problems manifested in various forms to present a grim of woes across the lengths and breaths of the nation. Pollution with other types of degradation such as erosion, loss of fertility and the continuing speed of urbanization are the major threat to the sustainability of soil resources in Nigeria (Bankole, 2005). Wide varieties of waste are dumped on soils. A dumpsite may consist of plastics, discarded cans, fins, pail and machine parts, dry cells, paints etc.

In addition, increased auto-mobile repairs/workshop activities in Nigeria due mainly to large inflow of used "tokunbo" vehicles into the country in the late 1990s contributed markedly to the problem of groundwater contamination in most cities. Automobile used waste oil contain oxidation products, sediments, water and metallic particles resulting from machinery wears, organic and inorganic chemicals used in oil additives and metals that are present in fuel and transferred to the crankcase during combustion (EEA, 2007). Wear metals are formed in lube oils. Under the harsh conditions of temperature and pressure, the surface of the metal piece becomes slightly oxidized, forms salts with the degradation products of the oils and becomes soluble in the oil. The friction of motion in machinery causes micro-fine particles to shear off the surface and become suspended in the oil (Anonymous, 1995). These wastes, including also waste oil used for cleaning during services, metal scraps, waste tyres, used batteries etc.

indiscriminately discarded on soils by artisans contaminates the soil and the water that makes its way through in to the underground water table. Percolation of leachates from these materials poses threats to underground water. While other sources of groundwater contamination have been well discussed, little is mentioned on the impact of automobile artisans on the eco-system.

2.2. Pollution Risk and Aquifer Vulnerability

Unsaturated zone travel time and aquifer residence time are important factors in any aquifer assessment, because they affect the ability of the aquifer to eliminate or mitigate contamination from activities at the land surface.

Even if the contaminant is not easily degraded so that the total quality reaching the groundwater resource is not greatly reduced, some aquifer systems are better able to mitigate the effects of groundwater quality degradation than others, for example, a saturated aquifer with high storage capacity, holds much water that could dilute contaminant concentration to acceptable limits

2.2.1 Using Aquifer Vulnerability to Assess Pollution Risk.

Groundwater pollution risk can be illustrated as the interaction between two semi-independent factors (Custodio, 2002);

- The contaminant load that is applied to the surface environment as a result of human activity.
- The natural pollution vulnerability of the aquifer.

The term aquifer pollution vulnerability is used to represent the intrinsic characteristics of the aquifer that determine whether it is likely to be affected by an imposed contaminant load.

Vulnerability assessment is based on the potential contaminant attenuation capacity from the surface to the water table (or to the aquifer in the case of semi-confined groundwater systems. Aquifer vulnerability can be subdivided in to four broad classes as given in the table below.

Table 2.1 Definition of Aquifer Vulnerability Classes

S.No	Vulnerability class	Definition
1	Extreme	Vulnerable to most water pollutants with relatively rapid impact in many pollution scenarios.
2.	High	Vulnerable to many pollutants except those, highly adsorbed or readily transformed.
3.	Low	Only vulnerable to the most persistent pollutants in the very long term.
4.	Negligible	Continuing beds present with no significant groundwater flow across them.

Source: Groundwater resources of the world (UNEP, 2003)

Extreme vulnerabilities are associated with highly fractured aquifers with a shallow water table as they offer little chance for contaminant attenuation. However, all aquifers are vulnerable to persistent contaminants derived from a wide-spread polluting activity. Other considerations that will determine whether the risk of aquifer pollution will result in serious threat to the quality of groundwater already developed or designated for water supply include;

- Mobility and lateral transport of contaminants within the aquifer and the position of the pollution source relative to the groundwater abstraction site;
- Magnitude of the pollution episode;
- Design and construction of the well;
- Value of the groundwater resources.

2.3 Factors that Affect Degree of Groundwater Pollution

2.3.1 Class of Contaminants

Mobility and persistence are the key properties of a contaminant in respect to its potential to contaminate groundwater. Mobility refers to the ease with which the contaminant is leached to the water table. Non-mobile compounds tend to be retained in the soil as a result of sorption, cation exchange or precipitation processes. Some compounds may be mobile but are impersistent and degrade rapidly to simple, generally non-toxic compounds.

2.3.2 Intensity of Contamination

As the intensity of contamination increases, so the potential for groundwater contamination increases (UNEP, 2003). It is generally considered that at a low intensity of application, the soil zone is able effectively to eliminate and attenuate many contaminants, but that above a certain critical threshold a progressing greater percentage of the contaminant will be leached.

2.3.3 Mode of Disposition

The mode of disposition refers to both the areal extent and where within the saturated-unsaturated profile the application is made. Diffuse or multipoint pollution sources produce widespread contamination of generally low concentration conversely, point source pollution produces localized contamination often of high concentration.

The soil layer is generally the most effective layer in attenuating contaminants. Thus, contaminants that by-pass this layer (for example, seepage from soakaways, drains and solid waste disposal pits or farm leaking underground tanks) may pose a more serious threat to groundwater than the contaminants applied directly to the surface.

2.3.4 Duration of Application

The duration of the contamination episode is also important. The release of contaminants in to the aquifer over a short period may be effectively dispersed and diluted during migration through the saturated zone, particularly in the deeper groundwater system. Important exceptions will arise where the contaminants are especially toxic (for example, chlorinated solvents, some heavy metals, radioactive wastes etc.) such that even small quantities can cause serious groundwater pollution.

2.4 Pollution Prevention Guide for Auto-mobile Repair Shops

The potential risk to ground water contamination by effluents from automobile repair sites can be high. Often, the types of waste fluids that are used to clean parts, used motor oil, coolant, and other fluids can be characterized as hazardous and/or dangerous wastes. The waste fluids, if washed down a drain and into a motor vehicle waste disposal well, could pose a serious risk to human health if ground water were to become contaminated. Table 2.2 provides a list of typical wastes that could be washed into a motor vehicle waste disposal well, and eventually make their way to ground water.

Table 2.2 Typical Automobile Fluid Wastes

S/No	Operation	Waste material	Pollutants
1	Shop Cleanup	Out-dated Supplies	Solvents, caustic cleaners, oils, alcohols, ethylene glycol, acids.
		Alkaline Floor Cleaner	Caustics, oil and grease, heavy metals.
2	Parts Cleaning	Solvents	Petroleum distillates, aromatic hydrocarbons, mineral spirits, naphtha, chlorinated compounds, oil and grease, heavy metals.
		Aqueous Cleaners	Acids and alkalis, oil and grease, heavy metals, blended heavy oils.
3	Auto Maintenance	Motor Oil.	Blended mineral oil, heavy metals.
		Transmission Fluid.	Blended mineral oil, heavy metals.
		Engine Coolant	Ethylene glycol, lead.
		Batteries	Sulfuric acid, lead.

Source: (United States Environmental Protection Agency. Guides to Pollution Prevention: The Automotive Repair Industry).

2.4.1 Establishing Good Housekeeping Practices

2.4.1.1Solvents

Automobile repair shops typically use solvents in a variety of operations including parts cleaning, degreasing, and painting. Many of these solvents may be classified as hazardous waste, and may therefore require expensive treatment and/or disposal.

- Try to find one multi-purpose solvent that can serve a variety of uses, rather than having a different solvent for each operation. This will minimize the number of waste streams and increase the recycling potential of the spent solvent.
- Substitute less hazardous substitutes for solvent cleaners. Consider water based cleaners.
- Minimize the amount of cleaning solvents lost during drainage of cleaned parts; remove parts from the bath slowly to prevent spillage; install drip trays or racks near the bath for draining cleaned parts; return the drainage to the bath.

2.4.1.2 Oils

Use drip pans to catch lube oils for reuse; handle oils carefully to avoid spillage. Also contact a reputable recycler to collect your used oil.

2.4.1.3 Other wastes

- Use paint with higher solids content, or water based paints with no solvent, whenever possible.
- Collect all scrap metals and take it to a metal recycler.
- Consider recycling scrap tyres, it may be cost effective to contract with a tyre recycler, rather than send them to a landfill.

2.5 Some Physio-chemical Properties of Groundwater

2.5.1 Odour

Odour is recognized as a quality factor affecting acceptability of potable water and food prepared from it, tainting of fish and other aquatic organisms and aesthetics of recreational waters. Most organic and some inorganic chemicals contribute taste or odour. These chemicals may originate from municipal and industrial waste discharges, natural sources, such as decomposition of vegetable matter or from associated microbial activity.

2.5.2 Turbidity

The Turbidity in water is the reduction of transparency due to the presence of particulate matter such as clay or silt, finely divided organic matter, plankton or other microscopic organisms. These cause light to be scattered and absorbed rather than transmitted in straight lines through the sample. The colloidal materials that exert turbidity provide adsorption sites for chemicals that may be harmful or cause undesirable tastes and odors. Disinfection of turbid water is difficult because of the adsorptive characteristics of some colloids and because the solids may partly shield organisms from disinfectants. In natural water bodies, turbidity may impart a brown or other colour to water and may interfere with light penetration and photosynthetic reaction in streams and lakes.

2.5.3 pH Value

pH value is the logarithm of reciprocal of hydrogen ion activity in moles per liter. In water solution, variations in pH value from 7 are mainly due to hydrolysis of salts of strong bases and weak acids or vice versa. Dissolved gases such as carbon di oxide, hydrogen sulphide and ammonia also affect the pH of water. The overall pH range of natural water is generally between

6 and 8. Industrial wastes may be strongly acidic or basic and their effect on pH value of receiving water depends on the buffering capacity of water. pH lower than 4 will produce sour taste and higher value above 8.5 bitter taste. Higher value of pH, hasten the scale formation in water heating apparatus and reduce the germicidal potential of chlorine. pH below 6.5 starts corrosion in pipes, thereby releasing toxic metals such as Zn, Pb, Cd, Cu etc.

2.5.4 Total Hardness

Hardness of water is caused by the presence of multivalent metallic cations and is largely due to calcium, Ca++, and magnesium, Mg++ ions. Hardness is reported in terms of CaCO3. Hardness is the measure of capacity of water to react with soap, hard water requiring considerably more soap to produce lather. It is not caused by single substance but by a variety of dissolved polyvalent metallic ions, predominantly calcium and magnesium cations. The low and high value of Hardness has advantages and disadvantages. Absolutely soft water is tasteless. On the other hand, hardness up to 600 mg/l can be relished if got acclimatized to. Moderately hard water is preferred to soft water for irrigation purposes. Absolutely soft water is corrosive and dissolves the metals. More cases of cardiovascular diseases are reported in soft water areas. Hard water is useful to growth of children due to presence of calcium.

2.5.5 Iron

Anaerobic ground waters may contain iron II at concentrations up to several milligrams per liter without discoloration or turbidity in the water when directly pumped from a well. Taste is not usually noticeable at iron concentrations below 0.3 mg/l, although turbidity and colour may develop in piped systems at levels above 0.05 to 0.1 mg/l. Iron is an essential element in human nutrition. Estimates of the minimum daily requirement for iron depend on age, physiological status, sex and iron bio-availability and range from about 10 to 50 mg/day.

Although iron has got little concern as a health hazard but is still considered as a nuisance in excessive quantities. Long time consumption of drinking water with a high concentration of iron can lead to liver diseases

(hemosiderosis). Iron also promotes the growth of iron-bacteria. This gives a rusty appearance to the waters. Colonies of these bacteria may also form a slime which causes problems in water closets, pipes, pumps and distribution system. High concentration of iron in water is not suitable for processing of food, beverages, ice, dyeing, bleaching and many other items. Water with high concentration of the iron when used in preparation of tea and coffee, interacts with tanning giving a black inky appearance with a metallic taste. Coffee may even become unpalatable at concentration of iron more than 1 mg/l.

2.5.6 Chlorides

Chloride is one of the major inorganic anion in water. In potable water, the salty taste is produced by the chloride concentrations is variable and dependent on the chemical composition. There is no known evidence that chlorides constitute any human health hazard. For this reason, chlorides are generally limited to 250 mg/l in supplies intended for public use. In many areas of the world where water supplies are scarce, sources containing as much as 2000 mg/l are used for domestic purposes without the development of adverse effect, once the human system becomes adapted to the water. High chloride content however, may harm metallic pipes and structures as well as growing plants.

2.5.7 Colour

Colour in water may be due to the inorganic ions, such as iron and manganese, humus and peat materials, plankton, weeds and industrial wastes. The term colour is used to mean the true colour of water from which turbidity has been removed. The term apparent colour includes not only the colour due to substances in solution but also that due to suspended matter. Apparent colour is determined on the original sample without filtration or centrifugation.

2.5.8 Total Dissolved Solids

Total dissolved solids is the term applied to the residue remaining in a weighed dish after the sample has been passed through a standard fibre glass filter and dried to constant mass at 103 – 105oC or 179 – 181 o C. Many dissolved substances are undesirable in water. Dissolved minerals, gases and organic constituents may produce aesthetically displeasing colour, taste and odor. Some dissolved organic chemicals may deplete the dissolved oxygen in the receiving waters and some may be inert to biological oxidation, yet others have been identified as carcinogens. Water with higher solids content often has a laxative and sometimes the reverse effect upon people whose bodies are not adjusted to them. High concentration of dissolved solids, about 3000 mg/l may also produce distress in livestock.

2.5.9 Calcium

Calcium is a major constituent of various types of rock. It is one of the most common constituents present in natural waters ranging from zero to several hundred milligrams per liter depending on the source and treatment of the water. Calcium is a cause for hardness in water and incrustation in boilers.

2.5.10 Magnesium

Magnesium is a common constituent in natural water. Magnesium salts are important contributors to the hardness of water which break down when heated, forming scale in boilers. The magnesium concentration may vary from zero to several hundred milligrams. Chemical softening, reverse osmosis, electro dialysis, or ion exchange reduces the magnesium and associated hardness to acceptable levels.

2.5.11 Copper

Copper is found mainly as a sulphide, oxide, or carbonate in the minerals. Copper enters the water system through mineral dissolution, industrial effluents, because of its use as algaecide and insecticide and through corrosion of copper alloy water distribution pipes. It may occur in simple ionic form or in one of many complexes with groups, such as cyanides, chlorides, ammonia or organic ligands. The tests for copper is essential because of dissolved copper salts even in low concentrations are poisonous to some biota. Desirable limit for copper in potable water is 0.05 mg/l maximum which can be relaxed in the absence of better alternate source to 1.5 mg/l

2.5.12 Manganese

The intake of manganese can be high as 20 mg/day without apparent ill effects.

It should be noted that manganese may be objectionable to consumers if it is deposited in water mains and causes water discoloration. Although concentrations below 0.1 mg/liter are usually acceptable to consumers, this may vary with local circumstances.

2.5.13 Sulphate

The major physiological effects resulting from the ingestion of large quantities of sulfate are catharsis, dehydration, and gastrointestinal irritation. Water containing magnesium sulfate at levels above 600 mg/l acts as a purgative in humans. The presence of sulfate in drinking water can also result in a noticeable taste. The lowest taste threshold concentration for sulfate is approximately 250 mg/l, as the sodium salt. Sulfate may also contribute to the corrosion of distribution systems.

2.5.14 Nitrate

Nitrates generally occur in trace quantities in surface waters but may attain high levels in some ground waters. Nitrite in water is either due to oxidation of ammonium compounds or due to reduction of nitrate. It can be toxic to certain aquatic organisms even at concentration of 1 mg/l. In excessive limits, it contributes to the illness known as methenoglobinemia in infants.

2.5.15 Fluoride

Traces of fluorides are present in many waters. Higher concentrations are often associated with underground sources. In seawater, a total fluoride concentration of 1.3 mg/l has been reported. In groundwater, fluoride concentrations vary with the type of rock that the water flows through but do not usually exceed 1.0 mg/l. Presence of large amounts of fluoride is associated with dental and skeletal fluorosis (1.5 mg/l) and inadequate amounts with dental caries (< 1mg/l).

2.5.16 Zinc

Zinc is an essential and beneficial element in body growth. Concentrations above 5 mg/l may cause a bitter astringement taste and opalescence in alkaline water. Zinc most commonly enters the domestic supply from deterioration of galvanized iron and dezincification of brass. Zinc in water may also come from individual water pollution.

2.5.17 Alkalinity

Alkalinity of water is its quantitative capacity to react with a strong acid to a designated pH. Highly alkaline waters are usually unpalatable. Excess alkalinity in water is harmful for irrigation which leads to soil damage and reduce crop yields. Alkalinity is significant in many uses and treatments of natural and wastewaters. Alkalinity measurements are used in the interpretation and control of water treatment processes.

2.5.18 Conductivity

Specific conductance yields a measure of water's capacity to convey an electric current. This property related to the total concentration of the ionized substances in water and the temperature at which the measurement is made, the nature of the various dissolved substances, their actual and relative concentrations, and the ionic strength of the water sample vitally affects the specific conductance.

2.6 Groundwater Contaminants

Groundwater contaminants refer to anything that affects the quality of groundwater adversely. They are generally grouped in to four classes;

- Inorganic contaminants
- Organic contaminants
- Micro-biological contaminants
- Radiological contaminants

For the purpose of this study, since a large amount of automobile composition is of inorganic and organic nature, we shall duel more on these classes of groundwater contaminants. For more details on these contaminants, their sources to groundwater and potential health and other effects to life, refer to appendix A

CHAPTER THREE

3.0MATERIALS AND METHODS

3.1 Background

The effects of automobile effluents on groundwater quality were evaluated by collecting and analyzing water samples from selected groundwater sources i.e. well and borehole at Keteren- Gwari automobile repair site in Minna.

3.2 Study Area

3.2.1 Location

The study area, Keteren-Gwari is located within Minna, the Niger state capital in Northern Nigeria. Its geographical coordinates are 9° 36′ N, 6° 33′ E. The automobile repair site where the study was carried out has been established for approximately 26years as at the time this study. Figure 3.1 below shows a cadastral map of the part of Minna in which the study area is located.

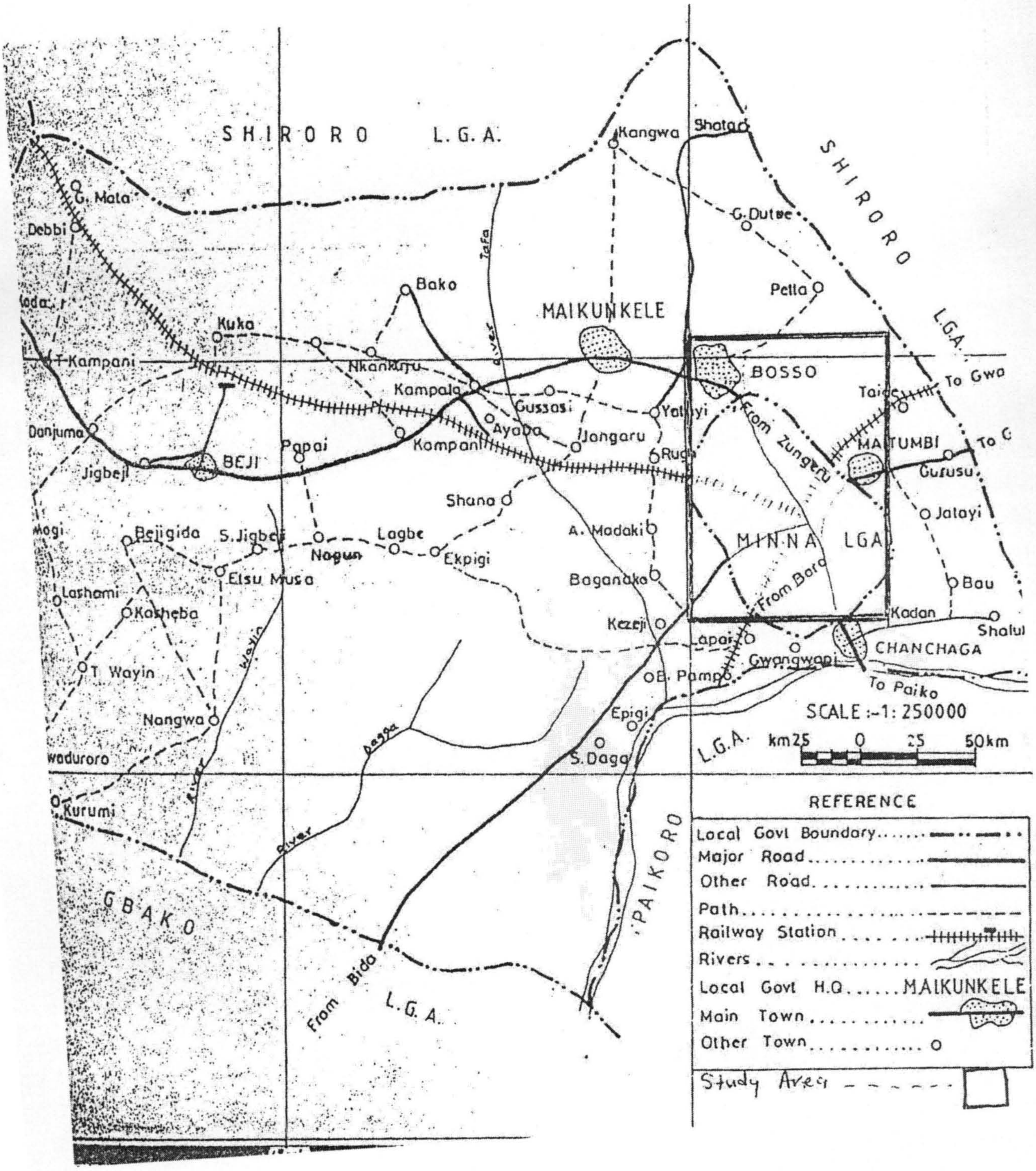

Fig. 3.1 Map of Bosso L.G.A of Niger State, Highlighting the Study Area

3.2.2 Climate

The total annual rainfall spreads over the month of April to October, with the highest amount in August. The average annual rainfall is about 1200mm and the mean annual temperature ranges between 29° and 35° during the dry season.

3.2.3 Relief

The relief of the study area is similar to the topography of most of the Northern parts of Nigeria consisting of relatively flat lying land with some sparsely distributed hills.

3.3 Sample Collection

Sampling bottles were carefully cleaned, sterilized and labeled. Groundwater sources in the area were located by enquiring from residents within the area. The labeled sampling bottles were then filled with water from one borehole and four wells within the study area. The samples were then dispatched at once to the laboratory for analysis.

3.4 Laboratory Analysis

3.4.1 Materials for Laboratory Analysis

The equipment and materials used for this analysis ranges from complex computerized equipment to simple ones like the water containers. Some of the equipments used for testing the water samples include

- Atomic absorption spectrophotometer
- Incubator
- Autoclaves

- Bunsen burner
- Inoculating loop
- PH meter
- Petri dishes
- Reagents and chemicals
- Refrigerator
- Oven
- Desiccators
- Water containers.

3.5 Analysis of Physical Parameters

In the process of carrying out the physical analysis of the water samples that were collected, the parameters that were tested for include taste, odour, colour, and turbidity.

3.5.1 Taste and Odour

The taste of water is measured by flavour threshold test. In this test, the water sample to be tested is diluted with water free from any taste, to such an extent that the mixture of the water sample and the added water just becomes taste free. The volume of the water sample and that of the taste free water added for dilution are measured and the taste of the water is expressed in terms of Flavour Threshold Number (FTN) which represents the dilution ratio at which the water sample looses its taste. The FTN is computed as follows.

$$FTN = \frac{A+B}{A} \tag{3.1}$$

Where A = volume of water sample in ml, and

B = volume of taste free water (or diluents) added in ml.

Equation 3.1 shows that the number of times the water is diluted to just make it taste free represents the flavour threshold number. Thus if diluting 25 ml of water sample 175 ml of taste free water is required to be added to make the water sample to just loose its taste, then the FTN will be eight.

The odour of water is measured by threshold odour test. In this test, the water sample to be tested is diluted with odour free water to such an extent that the mixture of the water sample and the added water just becomes odour free. The volume of water sample and that of the odour free water added for dilution are measured and the odour of the water sample is expressed in terms of the Threshold Odour Number (TON) which represents the dilution ratio at which the water sample looses its odour. The TON is computed as follows

$$\mathrm{TON} = \frac{\mathrm{A+B}}{\mathrm{A}} \qquad (3.2)$$

Where A = volume of water sample in ml, and

B = volume of odour free water (or diluents) added in ml.

Equation 3.2 shows that the number of times the water sample is diluted to just make it odour free represents the TON

3.5.2 Colour

The colour in water is measured by platinum-cobalt method. In this method, colour is measured by visual comparison of water sample with the standard coloured water prepared by dissolving platinum-cobalt in distilled water. The intensity of colour is expressed on the platinum-cobalt scale as the number of colour units. On this scale, one unit of colour is the colour produced by 1mg of platinum-cobalt dissolved in 1litre of distilled water. The standard coloured waters of different colour units are prepared in the laboratory for being used for comparison. A simple instrument called the tintometer is used for comparing the water to be tested with the standard coloured water.

3.5.3 Turbidity

Turbidity was determined using a turbidmeter (Nephelometer). Turbidity measurement using this method is based on comparison of the intensity of light scattered by the water sample under defined condition with the intensity of light scattered by a standard reference suspension under the same conditions. The intensity of light scattered at right angles to the incident light using formazin polymer as the reference standard suspension was measured and computed as the turbidity.

3.6 Analysis of Chemical Parameters

3.6.1Water pH

The pH value of each sample was measured using the pH meter. The pH meter was first calibrated, and then its electrode and surrounding area was rinsed with distilled water using the squeeze bottles and dried with soft tissue. A dry 100 ml beaky deep was filled to the 50 ml line with the water sample. The electrode was immersed into the water. The sample was stirred once and then the displayed value was allowed to stabilize. The value was read and recorded and the same procedure was repeated for the other samples.

3.6.2 Electrical Conductivity

A CMD 800 hydro check conductivity meter was used to determine the conductivity of the water sample. Before meaningful and repeatable measurement of conductivity was made, the setting for cell constant K and sample temperature were made for specific conductivity at 25°C or at least known for absolute measurement. To view the cell constant K, µs (micro siemens) was switched on to by key A. Then C + A (hold) – K was displayed. Making measurement, key A was switched on and cell inserted into test solution and then the reading was displayed.

3.6.3 Measurement of Hardness

The hardness of water is usually measured either by the soap solution test or the Versenate or ethylenediamine tetraacetic acid (EDTA) method. The EDTA method is considered to be more accurate. In this method, the total hardness is measured by titrating the water sample against EDTA or its sodium salt so as to form stable complex ions with the calcium or magnesium ions in water according to the following equation.

$$\begin{bmatrix} Ca^{++} \\ Mg^{++} \end{bmatrix} + \text{EDTA} = \begin{bmatrix} Ca\,.EDTA \\ Mg \end{bmatrix} \text{complex} \tag{3.3}$$

In the titration, Erichrome black T (alcoholic solution of blue dye) is used as indicator to show when all the ions causing hardness have been complexed. The indicator, when added in a small amount to a sample of hard water, buffered to a pH value of about ten by ammonia buffer solution, combines with a few calcium or magnesium ions to form a weak complex wine red in colour according to the following equation

$$\begin{bmatrix} Ca^{++} \\ Mg^{++} \end{bmatrix} + \text{Erichrome black T} = \begin{bmatrix} Ca.\,Erichrome\ black\ T \\ Mg \end{bmatrix} \text{complex} \tag{3.4}$$

This complex being unstable is quickly replaced by the $\begin{bmatrix} Ca.EDTA \\ Mg \end{bmatrix}$complex according to equation 3.3 noted above. Erichrome black T is freed in this process as indicated by the following equation.

$$\begin{bmatrix} Ca.Erichrome\ black\ T \\ Mg \end{bmatrix}\text{complex} + \text{EDTA} = \begin{bmatrix} Ca.EDTA \\ Mg \end{bmatrix}\text{complex} + \text{Erichrome black T} \quad (3.5)$$

The wine red colour is changed to distinct blue colour which indicates the end of titration. The total hardness of the water sample is given in mg/l or ppm by the following expression.

$$\text{Total hardness (mg/l or ppm)} = \frac{\text{ml of EDTA used} \times 100}{\text{ml of water sample}} \qquad (3.6)$$

3.6.4 Determination of Chloride

A suitable portion of the sample was diluted to100 ml. 3 ml Al $(OH)_3$ suspension was added, mixed, left to settle, and then filtered. If sulfate, sulfide or sulfite is present, 1 ml H_2O_2 is added and stirred for about 1 minute. 1 ml K_2CrO_4 indicator solution is then added and titrated with standard $AgNO_3$ titrant to a pinkish yellow end point. It is important to be consistent in end point recognition.

3.6.5 Determination of Nitrate

Two moles of NO_3^- react with one mole of chromotropic acid to form a yellow reaction product, the absorbance of which is measured at 410nm. The method can be used to determine nitrate concentrations in the range 0.1 – 5 mg NO_3^- - NL^{-1}. It is necessary to eliminate interference by nitrate, residual chlorine and certain oxidants which yield yellow colour when they react with chromotropic acid. Interference from residual chlorine and oxidizing agent can be eliminated by addition of sulfite. Urea eliminates nitrite interference by converting it to N_2 gas. Addition of antimony can mark up to 2000mg $Cl^- L^{-1}$.

3.6.5.1 Materials

- Spectrophotometer
- Cooling bath
- Stock nitrate solution, 100µg NO_3^-N mL^{-1} .Prepare by diluting a commercially available 1000 mg L^{-1} solution. Otherwise prepare as follows, dry sodium nitrate ($NaNO_3$) in an oven at 105°C for 24hours. Dissolve 0.607g of the dried salt in water and dilute to 100 ml.
- Working nitrate solution. 10µg NO_3^- - N mL^{-1}. Pipette 50mL of the stock solution into a 500 mL volumetric flask and make up to the mark with water.
- Sulphite – urea reagent. Dissolve 5g urea and 4g anhydrous Na_2SO_3 in water and dilute to 100 ml.
- Antimony reagent. Heat 0.5g of antimony metal in 80 ml of concentrated H_2SO_4 until all the metal has dissolved. Cool the solution and cautiously add to 20 ml iced water. If crystals form after standing overnight, redissolve the heating.
- Purified chromotropic acid solution (0.1%). Boil 125 ml of water in a beaker and gradually add 15 g of 4, 5-dihydroxyl-2, 7-naphthalene-disulfonic acid disodium salt, while stirring constantly. Add 5g of decolourising activated charcoal and boil the mixture for 10minute. Add water to make up for loss due to evaporation. Filter the hot solution

through cotton wool. Add 5g of activated charcoal to the filtrate and boil for 10minutes. Remove the charcoal completely from the solution by filtering, first through cotton wool and then through filtered paper. Cool and add slowly 10ml of concentrated H_2SO_4. Boil the solution down to 100 ml in a beaker and stand overnight. Transfer crystals of chromotropic acid to a Buchner funnel and wash thoroughly with 95% ethyl alcohol until crystals are white.dry the crystals in an oven at 80°C. Prepare a 0.1% solution by dissolving 100 mg of the purified chromotropic acid in 100 ml of concentrated H_2SO_4 and store in a brown bottle. This solution is stable for two weeks. If the sulphuric acid is free from nitrate impurities the solution should be colourless.

- Sulphuric acid, concentrated high purity.

3.6.5.2 Experimental procedure

Note

Results are more reliable when nitrate ion is determined in fresh samples. For short term preservation of up to 1day, samples can be stored in refrigerator at 4°C. if it is not possible to carry out the analysis promptly, samples can be preserved by adding 0.5-1.0ml of concentrated H_2SO_4 per litre of sample and store at 4°C.

Prepare nitrate standards in the range 0.1-5 mg $NO_3^-NL^{-1}$ by pipetting 1, 5, 10, 20, 40 and 50 ml of the working nitrate solution into a series of 100 ml volumetric flasks and making up to the mark with water. Filter the sample if significant amounts of suspended matter are present. Pipette 2 ml aliquots of samples, standards and a urea reagent to each flask. Place flasks in a trey of cool water with a temperature between 10-20°C and add 2 ml of the antimony reagent swirl the flasks when adding to each reagent. After the flasks has stood in the bath for about 4 minute. Add 1 ml of the antimony reagent. Swirl the flasks again and allow it to stand in the cooling bath for another 3 minute. Make up to the mark concentrated H_2SO_4 . Stop and mix with contents by inverting them 4 times. Allow the flasks to stand at room temperature for 45 minute and again adjust the volume to 10 ml with concentrated H_2SO_4. Finally, mix very gently to avoid introducing gas bubbles. Allow the flasks to stand for at least 15 minutes before measuring the absorbance at 410 nm using a 1cm cell with water in the reference cell. Subtract the absorbance reading of the water blank from the absorbances of samples and standard. Prepare a calibration graph of net absorbance against mg NO_3^- - NL^{-1} based on the standard measured and read off directly the concentration of NO_3^- (expressed as mg NL^{-1}) in the samples.

3.6.6 Copper, Lead, Manganese, Iron and Zinc.

Ethylenediamine tetraacetic acid (EDTA) with ammonium acetate is commonly used for the extraction of many elements. Diethylenetriamine pentaacetic acid(DTPA) is another common (universal) extractant and it is widely used for the simultaneous extraction of elements such as Zn, Cu, Fe and Mn (Lindsay and Norvell, 1978). Water samples are filtered and presented for instrumental analysis of the elements of interest using the bulk Atomic Absorption Spectrometer (AAS). The AAS is firstly calibrated using standard solutions of elements of interest and the sample readings are obtained in mg/l.

3.6.7 Determination of Sulphate

While traces of sulphate occur universally in all types of waters, its content may be appreciably high in several saline waters showing an electrical conductivity (EC) higher than 1 ds/m at 25 °C. Sulphate can be determined gravimetrically, colorimetrically, turbidimetrically or titrimetrically. Here, the turbidimetric method is described.Sulphate content is determined by the extent of turbidity created by precipitated colloidal barium sulphate suspension. Barium chloride solid crystals are added to ensure fine and stable suspension of BaSO4 at a pH of about 4.8. This also eliminates interference from phosphate and silicate. This fine suspension of BaSO4 is stabilized by gum acacia, and the degree of turbidity is measured with a turbidity meter or estimated spectrophotometrically at 440 nm.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

The results of analysis for the water samples A,B,C,D and E are presented in table 4.1,4.2,4.3 and 4.4 below respectively. Sample A represents water collected from a borehole or tube well within the test area while samples B,C,D and E represents water collected from open wells within the test area. A breakdown of the results obtained is given below

Table 4.1 Result of Water Analysis for Sample A

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
1	pH	-	6.5	6.5-8.5
2	Total Hardness	mg/l	11.6	100
3	Turbidity	NTU	ND	5
4	Conductivity	µs/cm	210	-
5	Sulphate	mg/l	118	200
6	Nitrate	mg/l	0.12	50
7	Ar	mg/l	ND	0.01
8	Cd	mg/l	ND	0.03
9	Cr	mg/l	ND	0.05

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
10	Cu	mg/l	ND	2.0
11	Fe	mg/l	0.23	0.05-0.3
12	Ni	mg/l	ND	-
13	Pb	mg/l	ND	0.01
14	Zn	mg/l	ND	5.0
15	Mn	mg/l	0.01	0.5

S.No = Serial number, ND = Not Detected, WHO = World Health Organization

Table 4.2 Result of Water Analysis for Sample B

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
1	pH	-	6.8	6.5-8.5
2	Total Hardness	mg/l	12.4	100
3	Turbidity	NTU	ND	5
4	Conductivity	µs/cm	300	-
5	Sulphate	mg/l	120	200
6	Nitrate	mg/l	0.16	3

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
7	Ar	mg/l	ND	0.01
8	Cd	mg/l	0.02	0.03
9	Cr	mg/l	0.02	0.05
10	Cu	mg/l	ND	2.0
11	Fe	mg/l	0.27	0.05-0.3
12	Ni	mg/l	ND	-
13	Pb	mg/l	ND	0.01
14	Zn	mg/l	2.0	5.0
15	Mn	mg/l	0.01	0.5

S.No = Serial number, ND = Not Detected, WHO = World Health Organization

Table 4.3 Result of Water Analysis for Sample C

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
1	pH	-	6.6	6.5-8.5
2	Total Hardness	mg/l	12.8	100
3	Turbidity	NTU	ND	5

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
4	Conductivity	µs/cm	288	-
5	Sulphate	mg/l	122	200
6	Nitrate	mg/l	0.14	3
7	Ar	mg/l	ND	0.01
8	Cd	mg/l	0.01	0.03
9	Cr	mg/l	0.02	0.05
10	Cu	mg/l	ND	2.0
11	Fe	mg/l	0.26	0.05-0.3
12	Ni	mg/l	ND	-
13	Pb	mg/l	ND	0.01
14	Zn	mg/l	2.0	5.0
15	Mn	mg/l	0.01	0.5

S.No = Serial number, ND = Not Detected, WHO = World Health Organization

Table 4.4 Result of Water Analysis for Sample D

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
1	pH	-	6.4	6.5-8.5
2	Total Hardness	mg/l	13.2	100
3	Turbidity	NTU	ND	5
4	Conductivity	µs/cm	284	-
5	Sulphate	mg/l	120	200
6	Nitrate	mg/l	0.16	3
7	Ar	mg/l	ND	0.01
8	Cd	mg/l	0.01	0.03
9	Cr	mg/l	0.01	0.05
10	Cu	mg/l	ND	2.0
11	Fe	mg/l	0.27	0.05-0.3
12	Ni	mg/l	ND	-
13	Pb	mg/l	ND	0.01

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
14	Zn	mg/l	1.0	5.0
15	Mn	mg/l	0.01	0.5

S.No = Serial number, ND = Not Detected, WHO = World Health Organization

Table 4.5 Result of Water Analysis for Sample E

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
1	pH	-	6.8	6.5-8.5
2	Total Hardness	mg/l	13.4	100
3	Turbidity	NTU	ND	5
4	Conductivity	µs/cm	290	-
5	Sulphate	mg/l	120	200
6	Nitrate	mg/l	0.18	3
7	Ar	mg/l	ND	0.01
8	Cd	mg/l	0.02	0.03
9	Cr	mg/l	0.01	0.05
10	Cu	mg/l	ND	2.0

S.No	Parameter	Unit	Measured Value	Standard Value (WHO)
11	Fe	mg/l	0.28	0.05-0.31
12	Ni	mg/l	ND	-
13	Pb	mg/l	ND	0.01
14	Zn	mg/l	2.0	5.0
15	Mn	mg/l	0.01	0.5

S.No = Serial number, ND = Not Detected, WHO = World Health Organization

4.1 Discussion of results

4.1.1 pH

The range of pH values obtained from the test samples ranged from 6.5-6.8, sample A having the least value of 6.5 and samples B and E having the highest value of 6.8. Values recorded were within stipulated WHO pH tolerance limit of between 6.5-8.5. Based on this, the pH of the water from all the sample sites would not adversely affect its use for domestic or recreational purposes.

4.1.2 Sulphate

Sulphate levels in all the water samples analysed varied from 118-122 mg/l. Sample A having the least value of 118 mg/l and sample C having the highest value of 122 mg/l. None of the water samples had sulphate level exceeding 200 mg/l which is the WHO maximum permissible level drinking water

4.1.3 Nitrate

Nitrate levels in the water samples ranged between 0.12 and 0.18 mg/l. Nitrate toxicity increases the risk of anemia in infants and pregnant women and formation of carcinogenic nitrosamines (Bush and Meyer, 1982). The WHO guideline for domestic water supply states limit of 3 mg/l for nitrate levels. None of the samples exceeded this limit thus, nitrate concentration is not considered to pose a problem for domestic use of water from the sample sources.

4.1.4 Turbidity

Turbidity stems from the reduction of transparency due to the presence of particulate matter such as clay, silt, finely divided organic matter , plankton or other microscopic organisms. The colloidal materials provide adsorption sites for chemicals that may be harmfull to health or cause undesirable tastes or odours. Turbidity was infinitesimal and therefore not Detected by test means carried out during the analysis.

4.1.5 Conductivity

Conductivity indicates the presence of dissolve solids and contaminants especially electrolytes but does not give information about specific chemical. Most drinking waters have conductivity measurement below 2000 µs/cm but the recommended value is 250 µs/cm. The values for conductivity in the test sample ranged from 210-300 µs/cm. sample A recorded the lowest value of 210 µs/cm while sample B recorded the highest value of 300 µs/cm

4.2 Heavy Metal Contents of Water Samples Analyzed

4.2.1 Copper, Arsenic, Nickel and Lead

Levels of the heavy metals listed i.e Cu, Ar, Ni and Pb in all the samples tested were infinitesimal and therefore could not be detected by test method used in the analysis of the samples. WHO permissible level for Cu, Ar, Ni an Pb in drinking water is 2.0 mg/l, 0.01 mg/l, -, and 0.01 mg/l respectively Since these heavy metals were not detected in the tested samples, they do not pose any immediate threat to health if water from the sample sources is ingested.

4.2.2 Zinc.

Zinc levels in the water samples ranged between 0-2mg/l. it was not detected at all in sample A, and had the highest level 2mg/l in samples B,C and E. All of these values fall below the 5.0mg/l highest desirable level for zinc in drinking water (WHO, 1984).

4.2.3 Manganese.

Manganese level in all the water samples analyzed, had a value of 0.01 mg/l. which is below the WHO standard of 0.5 mg/l maximum permissible level for manganese in potable water.

4.2.4 Iron

Values for iron in the water samples tested ranged between 0.23-0.28 mg/l, sample A having the least value of 0.23 mg/l and sample E having the most of 0.28 mg/l. these values are in line with the WHO standard range of between 0.05-0.3 mg/l for iron in potable water. Above this level, water would acquire taste and other aesthetic problems.

4.2.5 Chromium

Chromium levels in the water samples ranged from 0mg/l in sample A to 0.02 mg/l in samples B and E. these values fall below the WHO maximum permissible value of 0.05 mg/l for chromium in drinking water. Primary use of water high in chromium, could lead to adverse health effects such as renel disease and cancer (Salido and Jones, 1999).

CHAPTER FIVE

5.0 CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

From the results obtained, it is concluded that as at the time that this study was carried out, the location of the automobile repair site within the study area, did not yet have any significant effect on the ground water quality, since all the contaminants that were tested for, were either not detected or fell within range of World Health Organization (WHO) standard for maximum permissible values of these contaminants in potable water. Therefore, domestic use of water from groundwater sources located within the study area, will not pose an immediate health risk to residents within and around the area, as at the time of this study.

5.2 Recommendations

Based on the study carried out, the following recommendations were made;

1. Although all the samples tested were within safe limits, it was observed that the water sample A which was obtained from a borehole, had the least number of contaminants detected. This source of water is therefore a better source of water for domestic use by residents within the study area
2. Though not yet observed within the study area, mechanic workshops situated within residential areas are anthropogenic sources of heavy metals and other contaminants in soils that may pose serious threat to groundwater. Strickter environmental laws are therefore to be observed in this regard so as to curb this menace and all stake holders

involved in the use of auto-mechanic workshops need to be alerted of the impending dangers. Auto-mechanic workshops should be heavily cemented and proper drainage for used oils, lubricants and spilled gasoline constructed. Also, where possible, auto-mechanic repair workshops should not be located close to residential or commercial areas.

3. In future studies relating to this work, multiple auto-mechanic repair sites should be used and factors such as age of the site, topography of the area, type of soil etc. should be observed in relation between the test sites, to see how these factors bare a direct effect on the level of contamination of groundwater sources located within auto-mechanic repair sites.

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APPENDICES

APPENDIX A: Inorganic Contaminants, their Sources to Groundwater and Possible Health and Other effects

Inorganic Contaminants Found in Groundwater

contaminant	Source to groundwater	Potential health and other effects
Antimony	Enters environment from natural weathering, industrial production, municipal waste disposal, and manufacturing of flame retardants, ceramics, glass, batteries, fireworks, and explosives.	Decreases longevity, alters blood levels of glucose and cholesterol in laboratory animals exposed at high levels over their lifetime.
Arsenic	Enters environment from natural processes, industrial activities, pesticides, and industrial waste, smelting of copper, lead, and zinc ore.	Causes acute and chronic toxicity, liver and kidney damage; decreases blood hemoglobin. Possible carcinogen.
Beryllium	Occurs naturally in soils, ground water, and surface water. Often used in electrical industry equipment and components, nuclear power and space industry. Enters the environment from mining operations, processing plants, and improper waste disposal. Found in low concentrations in rocks, coal, and petroleum.	Causes acute and chronic toxicity; can cause damage to lungs and bones. Possible carcinogen.
Cadmium	Found in low concentrations in rocks, coal, and petroleum and enters the ground and surface water when dissolved by acidic waters. May enter the environment from industrial discharge, mining waste, metal plating, water pipes, batteries, paints and pigments, plastic stabilizers, and landfill leachate.	Replaces zinc biochemically in the body and causes high blood pressure, liver and kidney damage, and anemia. Destroys testicular tissue and red blood cells. Toxic to aquatic biota.

Chloride	May be associated with the presence of sodium in drinking water when present in high concentrations. Often from saltwater intrusion, mineral dissolution, industrial and domestic waste.	Deteriorates plumbing, water heaters, and municipal water-works equipment at high levels. Above secondary maximum contaminant level, taste becomes noticeable.
Chromium	Enters environment from old mining operations runoff and leaching into ground water, fossil-fuel combustion, cement-plant emissions, mineral leaching, and waste incineration. Used in metal plating and as a cooling-tower water additive.	Chromium III is a nutritionally essential element. Chromium VI is much more toxic than Chromium III and causes liver and kidney damage, internal hemorrhaging, respiratory damage, dermatitis, and ulcers on the skin at high concentrations.
Copper	Enters environment from metal plating, industrial and domestic waste, mining, and mineral leaching.	Can cause stomach and intestinal distress, liver and kidney damage, anemia in high doses. Imparts an adverse taste and significant staining to clothes and fixtures. Essential trace element but toxic to plants and algae at moderate levels.
Cyanide	Often used in electroplating, steel processing, plastics, synthetic fabrics, and fertilizer production; also from improper waste disposal.	Poisoning is the result of damage to spleen, brain, and liver.
Dissolved solids	Occur naturally but also enters environment from man-made sources such as landfill leachate, feedlots, or sewage. A measure of the dissolved "salts" or minerals in the water. May also include some dissolved organic compounds.	May have an influence on the acceptability of water in general. May be indicative of the presence of excess concentrations of specific substances, which would make water objectionable. High concentrations of dissolved solids shorten the life of hot water heaters.
Iron	Occurs naturally as a mineral from sediment and rocks or from mining, industrial waste, and corroding metals.	Imparts a bitter astringent taste to water and a brownish color to laundered clothing and plumbing fixtures.
Lead	Enters environment from industry, mining, plumbing, gasoline, coal, and as a water additive.	Affects red blood cell chemistry; delays normal physical and mental development in babies and young children. Causes slight deficit in attention span, hearing, and learning

		in children. Can cause slight increase in blood pressure in adults. Probable carcinogen.
Manganese	Occurs naturally as a mineral from sediment and rocks or from mining and industrial waste.	Causes aesthetic and economic damage, and imparts brownish stains to laundry. Affects taste of water, and causes dark brown or black stains on plumbing fixtures. Relatively non-toxic to animals but toxic to plants at high levels.
Mercury	Occurs as an inorganic salt and as organic mercury compounds. Enters the environment from industrial waste, mining, pesticides, coal, electrical equipment (batteries, lamps, and switches), smelting, and fossil-fuel combustion.	Causes acute and chronic toxicity. Targets the kidneys and can cause nervous system disorders.
Nickel	Occurs naturally in soils, ground water, and surface water. Often used in electroplating, stainless steel and alloy products, mining, and refining.	Damages the heart and liver of laboratory animals exposed to large amounts over their lifetime.
Sulphate	Elevated concentrations may result from saltwater intrusion, mineral dissolution, and domestic or industrial waste.	Forms hard scales on boilers and heat exchangers; can change the taste of water, and has a laxative effect in high doses.
Thallium	Enters environment from soils; used in electronics, pharmaceuticals manufacturing, glass, and alloys.	Damages kidneys, liver, brain, and intestines in laboratory animals when given in high doses over their lifetime.
Zinc	Found naturally in water, most frequently in areas where it is mined. Enters environment from industrial waste, metal plating, and plumbing, and is a major component of sludge.	Aids in the healing of wounds. Causes no ill health effects except in very high doses. Imparts an undesirable taste to water. Toxic to plants at high levels.

Appendix B Organic Contaminants Found in Groundwater

Contaminant	Source to groundwater	Potential health and other effects
Volatile organic compounds	Enter environment when used to make plastics, dyes, rubbers, polishes, solvents, crude oil, insecticides, inks, varnishes, paints, disinfectants, gasoline products, pharmaceuticals, paint removers, preservatives, degreasers and many more.	Can cause cancer and liver damage, anemia, gastrointestinal disorder, skin irritation, blurred vision, exhaustion, weight loss, damage to the nervous system, and respiratory tract irritation.
Plasticizers, chlorinated solvents, benzo[a]pyrene, and dioxin	Used as sealants, linings, solvents, pesticides, plasticizers, components of gasoline, disinfectant, and wood preservative. Enters the environment from improper waste disposal, leaching runoff, leaking storage tank, and industrial runoff.	Cause cancer. Damages nervous and reproductive systems, kidney, stomach, and liver.

Source: http// water science for schools/groundwater quality

RESULT OF PHYSICO CHEMICAL EXAMINATION

TD SON)	6.5-85	100	5	-	-	-	0.01	0.05	0.05	1	0.31	-	0.01	5		200	20	-	0.10
ample Name	PH	Total hardness mg/ca$_2$co$_3$	Turbidity	Tast	Odour	Colour	Ar Mg/l	Cd Mg/l	Cr (hee) Mg/l	Cu Mg/l	Fe Mg/l	Ni Mg/l	Pb Mg/l	Zn Mg/l	Co Mg/l	Soz Mg/l	Nitrate Mg/l	Conductivity Ms/cm	MN Mg/l
A	6.5	11.6	ND	Accept able	Unbeatable	Normal	ND	ND	ND	ND	0.23	ND	ND	ND	-	118	0.12	210	MN
B	6.8	12.4	ND	Like Slightly	Unbeatable	Normal	ND	0.02	0.02	ND	0.27	ND	ND	2	-	120	0.16	300	0.01
C	6.6	12.8	ND	Like Slightly	Unbeatable	Normal	ND	0.01	0.02	ND	0.26	ND	ND	2	-	122	0.14	288	0/01
D	6.4	13.2	ND	Like Slightly	Unbeatable	Normal	ND	0.01	0.01	ND	0.27	ND	ND	1	-	120	0.16	284	0.01
E	6.8	13.4	ND	Like Slightly	Unbeatable	Normal	ND	0.02	0.01	ND	0.28	ND	ND	2	-	120	0.18	290	0.01

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