ASSESSMENT OF CO-EXISTENCE OF PRIVIES AND WATER HOLES ON GROUND WATER QUALITY.

(A case Study of kuchi, Niger State)

BY

AHMAD MUHAMMAD

2004/21160EA

DEPARTMENT OF AGRICULTURAL AND BIORESOUCES ENGINEERING, FEDERAL UNIVERSITY OF TECHNOLOGY MINNA

FEBRUARY, 2010

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 Information derived from personal communications, published and unpublished work were duly referenced in the text.

Ahmad Muhammad

18/02/2010

Date

CERTICATION

his project entitled "Assessment of Co-existence of Privies and Water Holes on Ground Water)uality." by Ahmad Muhammad, meets the regulations governing the award of the degree of achelor of Engineering (B. ENG.) of the Federal University of Technology, Minna, and it is pproved for its contribution to scientific knowledge and literary presentation.

______________________ 17/2/10

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xternal Examiner — Date

DEDICATION

I dedicate this work to my wonderful parents for their support morally, financially and all forms of support required to achieve this height in life. My dedication also goes to my brothers and sisters for their support in every aspect and to my friends for their courage.

ACKNOWLEDGEMENT

I acknowledge the Almighty Allah for His mercy on me throughout my academic years and sincere appreciations to all my lectures that have contributed immensely to my success. Great thanks to my project supervisor Mr. P. A. Adeoye for his guidance and support. My gratitude also goes to my beloved parents, brothers and sisters and to everyone who have contributed to my success all through my life. You have made this possible for me, Thank you.

ABSTRACT

As a result of rapid urbanization in a context of economic constraints, the majority of rural residents in Africa live in villages often characterized by a lack of basic services such as water and sewerage. They use pit latrines and at the same time may draw domestic water from nearby wells. Overcrowding in this areas limits the adequate distance between wells and pit latrines so that micro-organisms migrate from latrines to water sources. This study sought to assess sanitary practices of residents of kuchi and fecal contamination of their domestic water sources. Ten different water samples were collected from ten different wells located in this area for laboratory analysis and their distances from the closest pit latrines were measured as well as the depths of the wells. The study found that most people in kuchi used shallow wells as their main source of domestic water and use pit latrines for excreta disposal, most of the children excrete on open field. The estimated distances between the pit latrines and the wells was generally short with most of the pit latrines being less than 15m from the wells. The WHO standard for the distance between a pit latrine and a water well is 15m and above. Total coliforms were present in water samples taken from the shallow wells with minimum and maximum values being 34 and120. The study suggests that the pit latrines were a major source of contamination of the wells with fecal matter. thus, the water from the wells in kuchi may not be suitable for human consumption. Efforts should be made to provide regulated tap water to this community and to other rural areas in Africa where tap water is not accessible. However, more sampling of different water sources is recommended.

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CHAPTER ONE

1.0 INTRODUCTION

Rapid urban growth in a climate of economic constraints has resulted in the majority of residents in Africa's large cities, and an increasing proportion of Africans overall, living in overcrowded villages and shantytowns. In these villages and shantytowns, health conditions and livelihood opportunities are poor. Available evidence indicates that the poor rural residents of Africa exhibit higher morbidity, have poor access to health services, and consequently exhibit higher mortality rates than residents of other areas.

The situation in Lavun Local Government is similar to other situations in Africa. Rapid urbanization amid economic degradation in nigeria has resulted in an increased proportion of people living in absolute poverty in the rural areas. This has overwhelmed the environmental health resources in urban areas. Because of their illegal status, residents of informal settlements in rural area do not receive government services such as water, drainage, sewerage, and rubbish collection. Consequently, informal settlements are characterized by poor environmental conditions that predispose their inhabitants to poor health outcomes. Evidence shows that children of poor families in these areas exhibit poorer health conditions than their urban counterparts. According to a report by African Population and Health Research Center (APHRC) in 2002, infant and child mortality risks are particularly higher in the rural areas than those observed in other urban areas. For instance, the under five mortality was 35% higher among rural residents than among the urban population in niger state. The report attributes these patterns to poor water and sanitation in these rural settlements.

An adequate supply of safe drinking water is universally recognized as a basic human need. Yet millions of people in the developing world do not have ready access to an adequate and safe water supply. In 1996, the number of people without access to safe water in urban areas was rising sharply in developing countries as a result of rapid urbanization, much of which was occurring in peri-urban and rural areas. Because the United Nations projects a rapid population growth in urban areas between 2000 and 2030, access to safe drinking water and adequate sanitation in urban areas is likely to worsen unless there is a drastic policy change to cater to the needs of the urban poor.

Human excreta and the lack of adequate personal and domestic hygiene have been implicated in the spread of many infectious diseases including cholera, typhoid, hepatitis, polio, cryptosporidiosis, ascariasis, and schistosomiasis. It is estimated that one-third of deaths in developing countries are caused by the consumption of contaminated water and on average as much as one-tenth of each person's productive time is sacrificed to water-related diseases. The World Health Organization estimates that 2.2 million people die annually from diarrhea diseases and that 10% of the population of the developing world are severely infected with intestinal worms related to improper waste and excreta management. In the rural areas, diarrheal diseases are among the major illnesses affecting children of the rural residents. According to the report by APHRC in 2002, prevalence of diarrhea was 32% among children below 5 years of age in the rural areas, which is double the rate for urban settlement and the national average.

Where ground water is used as a source of domestic water, use of pit latrines is not recommended because the two are incompatible unless the water table is extremely low and soil characteristics are not likely to contribute to contamination of ground water. Where they coexist, although it is difficult to give a general rule for all soil conditions, the commonly used guideline is that the well should be located in an area higher than and at least 15 m from the pit latrines and should be at least 2 m above the water table. Available evidence shows that increased lateral separation between the source of pollution and groundwater supply reduces the risk of fecal pollution. Coexistence of on-site sanitation and use of underground water has in the past been mainly confined to the rural areas where there is adequate land to allow for adequate distance between pit latrines and shallow wells. With the rapid urbanization and rapid expansion of rural settlements in Africa, on-site sanitation and underground water are used in some urban areas because they are affordable options in the absence of government-supplied services. However, the congestion in the urban areas does not allow for adequate distance between the wells and the pit latrines, which allows micro-organisms to migrate from fecal contents into the underground water sources. Furthermore, poor sanitary practices (for example, disposal of human excreta) in these areas lead to contamination of water and consequently water-borne diseases. It is in this context and in the context of high levels of water-borne diseases in the rural areas that this study sought to assess the sanitary practices and the fecal contamination of domestic water sources in kuchi village, lavun local government area in Niger state.

1.1 Objectives

(a) Study the impact of proximity of privy and water holes on the quality of water.

(b) To study if the orientation and location of the privy is having any effect on quality of water from the hole.

(c) To ascertain the reasonable distance between the privy and water holes that guarantee clean water.

1.2 Scope and Limitation of Work

By looking into the geological features and hydrological system of these areas and General assessment of the depths and distances between the privies and water holes and their degree of co-existence.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 Privy

A privy (latrine) is a structure (usually small, holding a single person, and freestanding) for defecation and urination. Latrines allow for safer and more hygienic disposal of human waste than open defecation. A pit toilet or composite toilet is a method of collection of human waste used for composting, controlled decomposition or waste disposal used most often in areas with no sewer system. They are used in rural areas and low-income urban communities, with significant use in the developing world. Many variations exist, but at its simplest, the reason for using a latrine is that waste is controlled and decomposed into safer by-products. (Coircross 1981).

2.1.1 Types of Privies

(1) The slit-trench latrine is the simplest type of pit toilet consisting of a relatively shallow (3-6 feet/1-2 meter in depth) trench narrow enough to stand with one leg on either side. This type is used either by squatting with the user's leg straddling the pit or by various arrangement for sitting or leaning against a support structure (Taqueer and Qureshi 1995). Such support may vary from the simplest form s such as a log, plank, branch or similar arrangement placed at right angles to the long axis of the pit. A dry pit does not penetrate the water table while a wet pit does.

(2) Ventilated improved pit latrine (VIP) is a pit toilet with a pipe (vent pipe) fitted to the pit and a screen (fly screen) at the top outlet of the pipe (Alirio 1986). VIP latrines are an improvement to overcome the disadvantages of simple pit latrines i.e flies and

mosquitoes nuisances and unpleasant odors. The smell is carried upwards by the chimney effect and flies are prevented from leaving the pit and spreading disease.

(3) Long-term pit toilets, the waste pit in some cases will be large enough that the reduction in mass of the contained waste products by the ongoing process of decomposition allows the pit to be more or less permanent . In other cases when the pit becomes too full, it will need to be periodically back filled and the associated structure is moved or rebuilt over the new waste pit dug in a new location. Pits may be dug or filled by hand using shovels but commonly excavation materials are used for such task.

(4) The double-vault ventilated composting latrine is currently the most advanced, free-standing latrine. Apart from offering significant reduction in risk from water borne diseases, this type of ecological sanitation provides the closure of some nutrient cycles by allowing the safe composted waste to be used as a free soil in agriculture.

(5) Permanent pit. Some pit toilet which are used by a great number of people such as a public restroom in rural areas or in a woodland park or busy lay-by rest stop or other similarly busy location are built with a concrete lining for permanence. In this type, the pit is periodically emptied usually by a pump mounted on a large truck which also carries a tank for storage. The waste is transported by road to a sewage treatment facility or to be composted elsewhere (Smith and Rahman 2000).

(6) Dry pit is a concrete-lined waste pit. A dry pit does not penetrate the water table while a wet pit does. In locations near streams or where under seepage may occur such as on a slope, the dry pit design may be preferred even in low traffic use. (Driscoll 1986)

2.1.2 Odor and Insect Control Mechanism

The principal mechanism of ventilation in latrines is the action of wind blowing across the top of the vent pipe. In case of the ventilated improved pit latrine (VIP), the wind creates a strong circulation of air through the structure down through the squat hole across the pit and up and out of the vent hole (EPA 2004). Unpleasant faecal odor from the pit contents are thus sucked up and exhausted out of the vent pipe leaving the structure odor-free. In some cases, solar powered fans are added giving a constant outwards flow from the vent pipe (Twarakari and kaluarachi 2006).

Flies searching for an egg-laying site are attracted by faecal odors coming from the vent pipe but they are prevented from entering by the fly screen at the outlet of the vent pipe. Some flies may enter into the pit via the squat hole and lay their eggs there. When new adult flies emerge, they instinctively fly towards light. However if the latrine is dark inside, the only light they can see is at the top of the vent pipe (Korte and Fernando 1991). Since the vent pipe is provided with a fly screen at the top, flies will not be able to escape and eventually they will die and fall back into the pit. To ensure that there is a flow of air through the latrine, there must be adequate ventilation of the structure. This is usually achieved by leaving openings above and below the door or by constructing a spiral wall without a door. (Walter 1981)

2.1.3 Hygienic Use

Covering the deposit prevents smells and discourages some fly species which might see it as a place to feed or reproduce. Earth, sand or saw dust (six inches) is added to the pit toilet after each use. Ashes and lime (one inch) are also effective. (Nickson and McArthur 2000)

2.1.4 Hazards/Gas Collection

Due to the possible danger cause by containing potentially explosive methane or other gases created by the decomposition of human waste as well as to provide a more pleasant-smelling outhouse, a ventilation pipe or other arrangements are used to allow the gases to escape. In some cases, the methane may be collected for later use as fuel. (Smedley and kinniburgh 2002)

2.2 WATER WELL

Water well is an excavation or structure created in the ground by digging, driving, boring or drilling to access water in underground aquifers. The well water is drawn by an electric submersible pump or a mechanical pump (e.g. from a water-pumping windmill), (William and walter 2006). It can also be drawn up using containers, such as buckets that are raised mechanically or by hand. Although not essential, a storage tank with a pressure of 40-60 psi is usually added to the system (after the pump), so the pump does not need to operate constantly. (Driscoll 1986)

Wells can vary greatly in depth, water volume and water quality. Well water typically contains more minerals in solution than surface water and may require treatment to soften the water by removing minerals such as arsenic, iron and manganese (Alirio 1986).

A well is made by reaching groundwater in the water table. Groundwater is stored naturally below the Earth's surface. Most groundwater originates as rain or snow that seeps into the ground and collects. Groundwater provides about 40 percent of the freshwater used in Africa. Most rural areas, and some cities depend on groundwater as their source for water (murkherje and Hossan 2006). Most rainwater is absorbed by the ground and fills the tiny spaces between soil particles.

However, excess water runs over the top of the soil until it reaches a river, stream, or reservoir. Runoff water brings pollutants it encounters along the way to the reservoir.

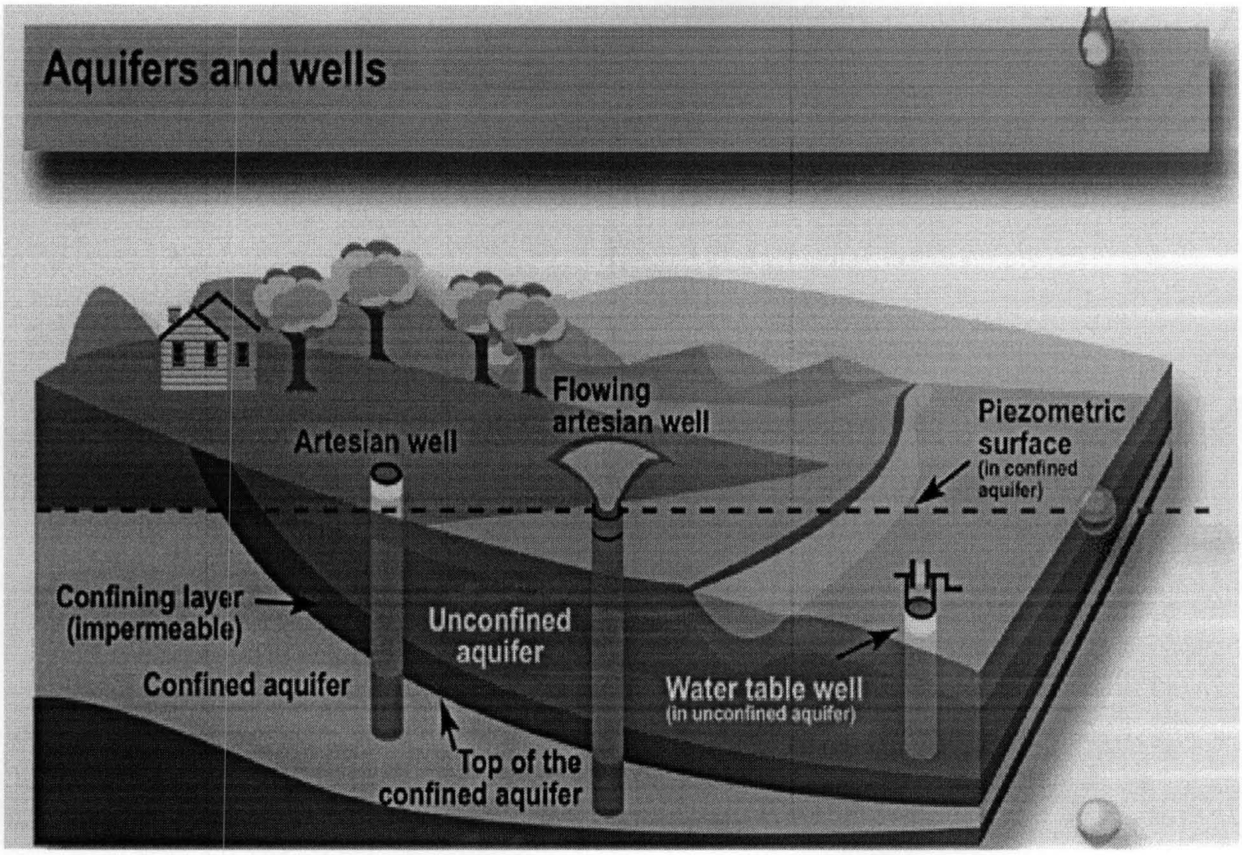

Fig.2.1: Aquifers and Wells.

As water seeps into the ground, it settles in the pores and cracks of underground rocks and into the spaces between grains of sand and pieces of gravel. In time, the water trickles down into a layer of rock or other material that is watertight (Taqueer and Qureshi 1995). This watertight zone collects the groundwater, creating a saturated zone known as an aquifer. Aquifers in the United States are usually made from gravel, sandstone, limestone, or basalt (volcanic rock). The water in the earth that these wells afford is at a place in the ground known as the water table. The water table is the level of the groundwater below the Earth's surface. This table is measured by the depth of the upper limit of the aquifer. The water table can be lowered by lack of precipitation or overdraft (William and Islam 2006).

Overdraft occurs when water is removed from the aquifer at a faster rate than can be naturally replenished by rain or snow. The lowering of the water table causes problems such as land subsidence, surface cracking, sinkholes on the surface, and damage to the aquifer's water producing character due to compaction. For instance, in the Chinese city of Shanghai, the earth was generally soft. People used to pump out groundwater from wells, leading to the eventual sinking of the surrounding strata (Nickson and McAthur 2000). Shanghai's city government was forced to seal all wells in the city in the 1960s. In coastal areas, overdraft can lead to saltwater intrusion. Saltwater intrusion occurs in low water tables where drops in water pressure can lead to the ocean backing up into the groundwater.

In a damp area, the water table can be reached simply by digging. In this case the well walls are usually lined with brick, stone, or concrete to keep the sides from caving in on the well. A dug well can be up to 50 feet (15 m) deep, and has the greatest diameter of any of the well types. Well water that contains a high number of dissolved minerals is called a mineral well. Except for areas containing Karst formations, underground water is considered fairly clean because soils create a filter that removes toxins with large molecules. (Michael 1998)

2.2.1 Types of Water Wells

(1) Dug wells

Until recent centuries, all artificial wells were pumpless dug wells of varying degrees of formality. Such primitive dug wells were excavations with diameters large enough to accommodate men with shovels digging down to below the water table. Relatively formal versions tended to be lined with laid stones or brick; extending this lining into a wall around the well presumably served to reduce both contamination and injuries by falling into the well. More modern dug wells may be hand pumped, especially in developing countries (Smith and Rahman 1991).

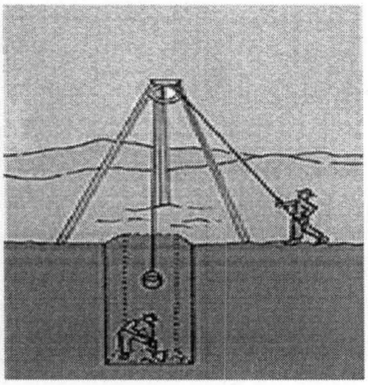

Plate.2.1: A Hand Dug Well under Construction.

(2) Driven wells

Driven wells may be very simply created in unconsolidated material with a "well point", which consists of a hardened drive point and a screen (perforated pipe). The point is simply hammered into the ground, usually with a tripod and "driver", with pipe sections added as needed. A driver is a weighted pipe that slides over the pipe being driven and is repeatedly dropped on it. When groundwater is encountered, the well is washed of sediment and a pump installed.

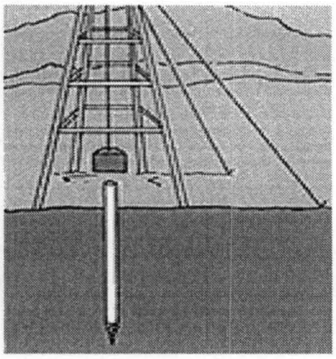

Plate.2.2: A Driven Well under Construction.

(3) Drilled wells

Drilled wells can get water from a much deeper level by mechanical drilling. Drilled wells with electric pumps are currently used throughout the world, typically in rural or sparsely populated areas, though many urban areas are supplied partly by municipal wells.

Drilled wells are typically created using either top-head rotary style, table rotary, or cable tool drilling machines, all of which use drilling stems that are turned to create a cutting action in the formation, hence the term 'drilling'. Most shallow well drilling machines are mounted on large trucks, trailers, or tracked vehicle carriages. Water wells typically range from 20 to 600 feet (180 m), but in some areas can go deeper than 3,000 feet (910 m).

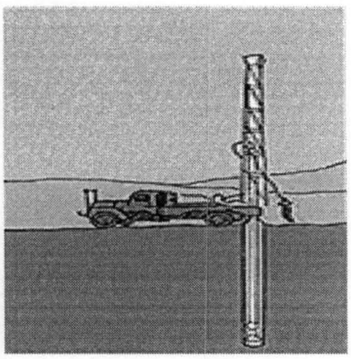

Plate.2.3: A Drilled Well under Construction.

Rotary drilling machines use a segmented steel drilling string, typically made up of 20-foot (6.1 m) sections of steel tubing that is threaded together, with a bit or other drilling device at the bottom end. Some rotary drilling machines are designed to install (by driving or drilling) a steel casing into the well in conjunction with the drilling of the actual bore hole. Air and/or water is used as a circulation fluid to displace cuttings and cool bits during the drilling (Korte and Fernando 1991). Another form of rotary style drilling, termed 'mud rotary', makes use of a specially made mud, or drilling fluid, which is constantly being altered during the drill so that it can consistently create enough hydraulic pressure to hold the side walls of the bore hole open, regardless of the presence of a casing in the well. Typically, boreholes drilled into solid rock are not cased until after the drilling process is completed, regardless of the machinery used (Twarakari and kaluarachi 2006).

The oldest form of drilling machinery is the Cable Tool, still used today. Specifically designed to raise and lower a bit into the bore hole, the 'spudding' of the drill causes the bit to be raised and dropped onto the bottom of the hole, and the design of the cable causes the bit to twist at approximately 1/4 revolution per drop, thereby creating a drilling action. Unlike rotary drilling, cable too l drilling requires the drilling action to be stopped so that the bore hole can be bailed or emptied of drilled cuttings.

Drilled wells are usually cased with a factory-made pipe, typically steel (in air rotary or cable tool drilling) or plastic/PVC (in mud rotary wells, also present in wells drilled into solid rock). The casing is constructed by welding, either chemically or thermodynamically, segments of casing together. If the casing is installed during the drilling, most drills will drive the casing into the ground as the bore hole advances, while some newer machines will actually allow for the casing to be rotated and drilled into the formation in a similar manner as the bit advancing just below (Smedley and kinniburgh 2002). PVC or plastic is typically welded and then lowered into the drilled well, vertically stacked with their ends nested and either glued or splined together. The sections of casing are usually 20' (6 m) or more in length, and 6" - 12" (15 to 30 cm) in diameter, depending on the intended use of the well and local groundwater conditions.

Surface contamination of wells in the United States is typically controlled by the use of a 'surface seal'. A large hole is drilled to a predetermined depth or to a confining formation (clay or bedrock, for example), and then a smaller hole for the well is completed from that point forward. The well is typically cased from the surface down into the smaller hole with a casing that is the same diameter as that hole. The annular space between the large bore hole and the smaller casing is filled with bentonite clay, concrete, or other sealant material. This creates an impermeable seal from the surface to the next confining layer that keeps contaminants from traveling down the outer sidewalls of the casing or borehole and into the aquifer. In addition, wells are typically capped with either an engineered well cap or seal that vents air through a screen into the well, but keeps insects, small animals, and unauthorized persons from accessing the well (EPA 1994). At the bottom of wells, based on formation, a screening device, filter pack, slotted casing, or open bore hole is left to allow the flow of water into the well. Constructed screens are typically used in unconsolidated formations (sands, gravels, etc.), allowing water and a percentage of the formation to pass through the screen. Allowing some material to pass through creates a large area filter out of the rest of the formation, as the amount of material present to pass into the well slowly decreases and is removed from the well (Alirio 1986).

Rock wells are typically cased with a PVC liner/casing and screen or slotted casing at the bottom, this is mostly present just to keep rocks from entering the pump assembly. Some wells utilize a 'filter pack' method, where an undersized screen or slotted casing is placed inside the well and a filter medium is packed around the screen, between the screen and the borehole or casing. This allows the water to be filtered of unwanted materials before entering the well and pumping zone. (Blyth and Fretas 1984)

2.2.2 Classification

Two broad classes of drilled-well types may be distinguished based on the type of aquifer which the well is completed in:

- shallow or unconfined wells are completed in the uppermost saturated aquifer at that location (the upper unconfined aquifer); or
- deep or confined wells, which are sunk through an impermeable stratum down into an aquifer which is sandwiched between two impermeable strata (aquitards or aquicludes). The majority of confined aquifers are classified as artesian because the hydraulic head in a confined well is higher than the level of the top of the aquifer. If the hydraulic head in a confined well is higher than the land surface it is a "flowing" artesian well (named after Artois in France).

Two additional broad classes of well types may be distinguished, based on the use of the well:

- production or pumping wells, are large diameter (> 15 cm in diameter) cased (metal, plastic, or concrete) water wells, constructed for extracting water from the aquifer by a pump (if the well is not artesian).

- monitoring wells or piezometers, are often smaller diameter wells used to monitor the hydraulic head or sample the groundwater for chemical constituents. Piezometers are monitoring wells completed over a very short section of aquifer. Monitoring wells can also be completed at multiple levels, allowing discrete samples or measurements to be made at different vertical elevations at the same map location. (Michael and Ojha 2003)

Obviously, a well constructed for pumping groundwater can be used passively as a monitoring well and a small diameter well can be pumped, but this distinction by use is common.

2.2.3 Contaminations

Shallow pumping wells can often supply drinking water at a very low cost, but because impurities from the surface easily reach shallow sources, a greater risk of contamination occurs for these wells when they are compared to deeper wells. In shallow and deep wells, the water requires pumping to the surface; in artesian wells, conversely, water usually rises to a greater level than the land surface when extracted from a deep source. (Walter 1981)

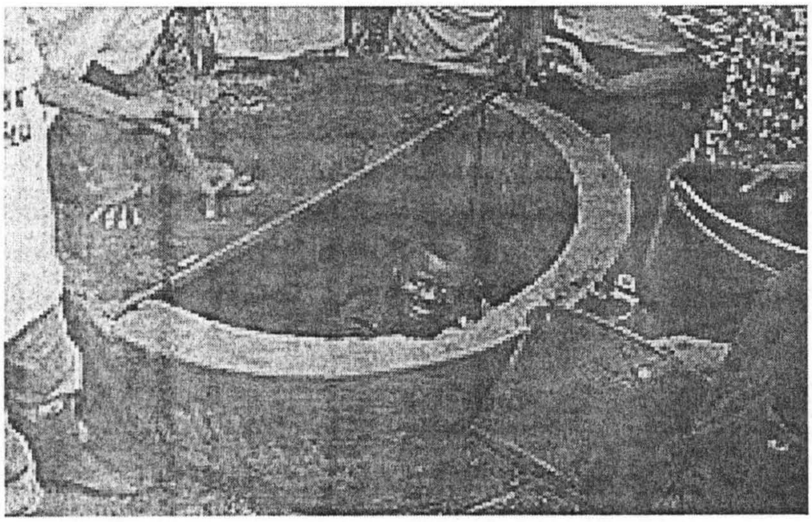

Plate.2.4: Man cleaning a well in Yaoundé, Cameroon

(1) Anthropogenic contamination

Contamination related to human activity is a common problem with groundwater. For example, benzene, toluene, ethylbenzene, and total xylenes (BTEX), which come from gasoline refining, and methyl-tert-butyl-ether (MTBE), which is a fuel additive, are common contaminants in urbanized areas, often as the result of leaking underground storage tanks. Many industrial solvents also are common groundwater contaminants, which may enter groundwater through leaks, accidental spills or intentional dumping (William and Walter 1991). Military facilities also produce considerable amounts of groundwater contamination, often in the form of solvents like trichloroethylene (TCE). Cleanup of contaminated groundwater tends to be very costly. Effective remediation of groundwater is generally very difficult (Mukherje and Hossain 2006)

(2) Natural contaminants

Some very common constituents of well water are natural contaminants created by subsurface mineral concentrations. Common examples include iron, magnesium and calcium. Large quantities of magnesium and calcium ions cause what is known as "hard water". Certain contaminants such as arsenic and radon are considered carcinogenic and therefore chronic contaminants. Other natural constituents of concern are nitrates and Coliform bacteria, both of which are considered acute contaminants and may seriously sicken persons considered to be "at risk", mainly the elderly, infirm and infants. Also of consequence can be radionuclides such as radium, uranium and other elements. (Walter 1981)

Arsenic contamination of groundwater is a natural occurring high concentration of arsenic in deeper levels of groundwater, which became a high-profile problem in recent years due to the use of deep tubewells for water supply in the Ganges Delta, causing serious arsenic poisoning to large numbers of people (Taqueer and Qureshi 1995). A 2007 study found that over 137 million people in more than 70 countries are probably affected by arsenic poisoning of drinking water. Arsenic contamination of ground water is found in many countries throughout the world, including the USA. Approximately 20 incidents of groundwater arsenic contamination have been reported from all over the world. Of these, four major incidents were in Asia, including locations in Thailand, Taiwan, and Mainland China. South American countries like Argentina and Chile have also been affected (William and Islam 2006). There are also many locations in the United States where the groundwater contains arsenic concentrations in excess of the Environmental Protection Agency standard of 10 parts per billion adopted in 2001. According to a recent film funded by the US Superfund, "In Small Doses". Millions of private wells have unknown arsenic levels, and in some areas of the US, over 20% of wells may contain levels that are not safe (EPA 2004).

Arsenic is a carcinogen which causes many cancers including skin, lung, and bladder as well as cardiovascular disease. Some research concludes that even at the lower concentrations, there is still a risk of arsenic contamination leading to major causes of death. A study was conducted in a contiguous six-county study area of southeastern Michigan to investigate the relationship between moderate arsenic levels and twenty-three selected disease outcomes (Nickson and McAthur 2000). Disease outcomes included several types of cancer, diseases of the circulatory and respiratory system, diabetes mellitus, and kidney and liver diseases. Elevated mortality rates were observed for all diseases of the circulatory system. The researchers acknowledged a need to replicate their findings.

A study preliminarily shows a relationship between arsenic exposure measured in urine and Type II diabetes. The results supported the hypothesis that low levels of exposure to inorganic arsenic in drinking water may play a role in diabetes prevalence. Arsenic in drinking water may also compromise immune function "Scientists link influenza A (H1N1) susceptibility to common levels of arsenic exposure" (Smith and Rahman 2000).

2.2.4 Odor and Color Problems

Well water users can sometimes experience odor or staining problems on appliances and laundry. Several of the more common complaints are described below.

- If there is a rotten egg odor associated with the well water, you may want to consider a hydrogen sulfide and methane analysis.
- If there is a musty or moldy odor with well water, an iron bacteria analysis should be conducted.
- If you are experiencing problems with red staining of fixtures, the iron level of the well water should be analyzed.
- If you are experiencing problems with brown or black staining of white laundry, have your water checked for manganese.

Once your water has been analyzed, you can compare your test results against EPA or state drinking water regulations to see if any contaminants are exceeding recommended levels. Once you have identified if any problems exist, you can begin your search for a specific treatment for your well water (Korte and Fernando 1991).

2.2.5 Basic Water Testing

(a) Bacteriological Test

The laboratory commonly will report the bacteriological test as positive or negative (absent), indicating the presence or absence of coliform bacteria. A satisfactory (negative) rating would mean the water is safe for human consumption from a bacteriological standpoint (Smedley and Kinniburgh 2002). Coliform bacteria are present in the intestinal tract of warm-blooded animals, including humans. While not a cause of disease by itself, its presence indicates probable contamination of the water supply and possible presence of disease organisms. This can lead to more serious problems for people with weakened immune systems, such as the very young, elderly or immuno-compromised individuals (EPA 2001).

A positive test (or greater than 1 per 100 milliliters of water) suggests further testing is necessary to include fecal coliform or E. coli bacteria testing. If such bacteria are present, the test confirms sewage or animal waste is contaminating the water and shock chlorination should be performed. Testing of this water should be repeated to confirm the effectiveness of this treatment (Twarakari and Kaluarachi 2006).

(b) Mineral Analysis

Alkalinity

Alkalinity is a measure of the capacity of water to neutralize acids. The predominant chemicals present in natural waters are carbonates, bicarbonates and hydroxides. The bicarbonate ion is usually prevalent. However, the ratio of these ions is a function of pH, mineral composition, temperature and ionic strength. Water may have a low alkalinity rating but a relatively high pH or vice versa, so alkalinity alone is not of major importance as a measure of water quality (William and Walter 2006).

Alkalinity is not considered detrimental to humans but generally is associated with high pH values, hardness and excess dissolved solids. High alkalinity waters also may have a distinctly flat, unpleasant taste. Treatment is an ion exchange via the addition of a tank media or reverse osmosis (Alirio 1986).

Arsenic

Arsenic is a semi-metal element in the periodic table. It is odorless and tasteless. It enters drinking water supplies from natural deposits in the earth or from agricultural and industrial practices. Studies have linked long-term exposure to arsenic in drinking water to cancer of the bladder, lungs, skin, kidney, nasal passages, liver and prostate. Noncancerous effects of ingesting arsenic include cardiovascular, pulmonary, immunological, neurological and endocrine (e.g., diabetes) effects. Short-term exposure to high doses of arsenic can cause other adverse health effects (Mukherhje and Hossain 2006). Treatment depends on the level of contamination. Typical recommendations include the addition of an anion filter or tank media.

Calcium and Magnesium

Calcium and magnesium are the main contributors to water hardness. When water is heated, calcium breaks down and precipitates out of the solution, forming scale. Maximum limits have not been established for calcium. Magnesium concentrations greater than 125 mg/l may have a laxative effect on some people. Treatment for calcium includes ion exchange through tank media and reverse osmosis. Magnesium levels can be controlled through distillation (Mukherje and Hossain 2006).

Chloride

High concentrations of chloride ions can cause water to have an objectionable salty taste and corrode hot-water plumbing systems. High-chloride waters have a laxative effect for some people. An upper limit of 250 mg/l has been set for chloride ions, although noticing the taste at this level is difficult and even higher concentrations do not appear to cause adverse health effects. An increase in the normal chloride content of water may indicate possible pollution from human sewage, animal manure or industrial wastes (Taqueer and Qureshi 1995). Treatment includes reverse osmosis.

Color

Color may be indicative of dissolved organic material, inadequate treatment, high disinfectant demand and the potential for the production of excess amounts of disinfectant byproducts. Inorganic contaminants, such as metals, are also common causes of color. In general, the point of consumer complaint is variable in a range from 5 to 30 color units, though most people find color objectionable in excess of 10 color units. Standards related to color: aluminum, color, copper, foaming agents, iron, manganese and total dissolved solids. (Roxanne and Tom 2009)

Conductivity

Conductivity is a measure of the conductance of an electric current in water. This is an easy measurement to make and relates closely to the total dissolved solids (mineral) content of water. The total dissolved solid is approximately 70 percent of the conductivity measured in microsiemens per centimeter. Maximum contaminant level (MCL) is 0.4 to 0.85 microsiemens per centimeter (William and Islam 2006). Treatment with reverse osmosis is effective for drinking water purposes

Fluoride

Concentrations of 0.7 to 1.2 mg/l fluoride will reduce the incidence of dental cavities. Low levels of fluoride are common in most groundwater. At concentrations of more than 1.5mg/l, fluorosis (mottling) of teeth may occur. This occurs only in developing teeth, before they push through the gums. Children under 9 should not drink water that has more than 2 mg/l of fluoride. Municipalities add fluoride to the water if it is not naturally occurring. Unless specified, bottled water does not contain fluoride; therefore, fluoride must be supplemented if consumption of water is limited to this source. Treatment of excess amounts includes reverse osmosis, activated alumina filters, deionization and/or distillation.

Iron and Manganese

Iron in concentrations greater than 0.3 mg/l and manganese in concentrations greater than 0.05 mg/l may cause brown and black stains on laundry, plumbing fixtures and sinks. A metallic taste also may be present and it may affect the taste of beverages made from the water. High concentrations of iron and manganese do not appear to present a health hazard. Treatment includes a water softener or iron filter for iron and reverse osmosis for manganese.

Nitrates

Nitrate (NO_3) levels should not be higher than 10 mg/L if reported as nitrogen (N) or nitrate-nitrogen (NO_3-N) or higher than 45mg/l if reported as nitrate (NO_3). High nitrate levels may cause methemoglobanemia (infant cyanosis or "blue baby disease") in infants who drink water or formula made from water containing nitrate levels higher than recommended.

Adults can drink water with considerably higher concentrations than infants without adverse effects. Livestock water can contain up to 100 mg/l of nitrate-nitrogen, but young monogastric animals, such as swine, may be affected at nitrate levels of considerably less than 100 mg/l. Treatment of such water includes anionic ion exchange, reverse osmosis, distillation and/or deionization.

pH

pH is a measure of the hydrogen ion concentration in water. A pH of 7 is neutral. pH under 7 indicates acidity; higher than 7 indicates alkalinity. Drinking water with a pH between 6.5 and 8.5 generally is considered satisfactory. Acidic waters are corrosive to plumbing and faucets, particularly if the pH is below 6. Waters with a pH above 8.5 may have a bitter or sodalike taste. The pH of water can affect the treatment of water and should be considered if the water is used for field application of pesticides. Water with a pH of 7.0 to 8.5 requires more chlorine for the destruction of pathogens (disease organisms) than water that is slightly acidic. Treatment is a neutralizer filter.

Potassium

Potassium concentrations in water are generally very small. Although excessive amounts may have a laxative effect, public health authorities have not established a maximum limit. Potassium (chloride) is used as a replacement for salt in water softeners when dietary sodium intake is a health issue.

SAR

The sodium adsorption ratio (SAR) is a measure of the relative proportion of the concentration of sodium ions to calcium and magnesium ions in the water. Excess sodium in irrigation water in relation to calcium and magnesium levels, plus the impact of the total salt content, can affect soil structure adversely and reduce the infiltration rate and soil aeration. An SAR of less than 6 is appropriate for lawn and garden irrigation, 6 to 9 may cause some problems in clay and silt loam soils, and any result over 9 will create problems with many soil types.

Sodium

Sodium is a very active metal that does not occur naturally in a free state. It always is combined with other substances. In the human body, sodium helps maintain the water balance.

Human intake of sodium mainly is influenced by the consumption of sodium as sodium chloride or table salt. The contribution of drinking water is normally small, compared with other sources. The treatment for certain heart conditions, circulatory or kidney diseases or cirrhosis of the liver may include sodium restriction. Diets for these people should be designed with the sodium content of their drinking water taken into account (Nickson and McAthur 2000).

The National Academy of Sciences has suggested a standard for public water allowing no more than 100 mg/l of sodium. This would ensure that the water supply adds no more than 10 percent of the average person's total sodium intake. The American Health Association recommends a more conservative standard of 20 mg/l to protect heart and kidney patients.

Softening by ion exchange or lime-soda ash increases the sodium content approximately 8 mg/l for each gr/gal (grain per gallon) of hardness removed Treatment includes the use of potassium chloride instead of sodium chloride softener pellets (softener salt) or alternatively, restrict drinking water from this source.

Sulphates

Water containing high levels of sulphates, particularly magnesium sulphate (Epson salts) and sodium sulphates (Glauber's salt), may have a laxative effect on people unaccustomed to the water. These effects vary among individuals and appear to last only until they become accustomed to using the water. High sulphate content also affects the taste of water and forms a hard scale in boilers and heat exchangers. The upper limit recommended for sulphates is 250 mg/l. Treatment includes reverse osmosis.

Total Dissolved Solids (TDS)

High concentrations of TDS may affect taste adversely and deteriorate plumbing and appliances. The EPA recommends that water containing more than 500 mg/l of dissolved solids not be used if other less mineralized supplies are available. However, water containing more than 500 mg/l TDS is not dangerous to drink. Exclusive of most treated public water supplies, a few freshwater lakes and scattered wells, very few water supplies contain less than the recommended 500mg/L concentration of total dissolved solids. Many households in the state use drinking water supplies with concentrations of 2,000 mg/l and greater (EPA 2004). Treatment for household use is reverse osmosis.

Total Hardness

Hardness is the property that makes water form an insoluble curd with soap and primarily is due to the presence of calcium and magnesium. Waters that are very hard have no known adverse health effects and may be more palatable than soft waters. Hard water is primarily of concern because it requires more soap for effective cleaning, forms scum and curd, causes yellowing of fabrics, toughens vegetables cooked in the water and forms scale in boilers, water heaters, pipes and cooking utensils. The hardness of good-quality water should not exceed 270 mg/l (15.5 grains per gallon) measured as calcium carbonate (EPA 2004). Waters softer than 30 to 50 mg/l may be corrosive to piping, depending on pH, alkalinity and dissolved oxygen. A water softener will correct hard water (more than 270mg/l) in this situation.

Turbidity

Turbidity is a measure of suspended minerals, bacteria, plankton, and dissolved organic and inorganic substances. Turbidity often is associated with surface water sources (Smith and Rahman 2000). Treatment includes mixing with a substance such as alum that causes coagulation of the suspended materials followed by sand filter filtration

2.2.6 Water Treatment

Well water for personal use is often filtered with reverse osmosis water processors; this process can remove very small particles. A simple, effective way of killing micro organisms is to boil the water (although, unless in contact with surface water or near areas where treated wastewater is being recharged, groundwater tends to be free of micro organisms). Alternately the addition of 1/8 teaspoon (0.625 mL) of bleach to a gallon (3.8 L) of water will disinfect it after a half hour.

Contamination of groundwater from surface and subsurface sources can usually be dramatically reduced by correctly centering the casing during construction and filling the casing annulus with an appropriate sealing material. The sealing material (grout) should be placed from immediately above the production zone back to surface, because, in the absence of a correctly constructed casing seal, contaminated fluid can travel into the well through the casing annulus. Centering devices are important (usually 1 per length of casing or at maximum intervals of 30 feet/9 m) to ensure that the grouted annular space is of even thickness. (smethust 1979)

CHAPTER THREE

3.0 MATERIALS AND METHODS

3.1 Site Study

Kuchi is a village in Lavun Local Government area in Niger State. It is located approximately between latitude 9.01° and 9.05° N, and longitude 5.99° and 6.01° E. it is populated with over 17,300 individuals (2006 census) with total area of 5 square kilometers. They are generally Nupe by tribe, most of the residents live in mud houses that are grouped into customary compounds. The village itself is well shaded by trees and it has a stream that runs alongside the village. Their annual rainfall is usually not more than 20 inches. They have a high water table level which makes it easy for them to get access to underground water. Their major occupations are farming and trading.

3.2 Methodology

Kuchi village was selected within Lavun Local Government area. A general survey study of this village was made and observations were recorded.

At kuchi, they have a total number of 930 house hold. The major sources of water noticed in this area are water wells and bore-holes. The total number of wells counted are 27 and they have only three bore-holes. All the 27 wells that are located in this area are shallow wells (defined as the hand dug wells) and the three bore-holes which are deep wells (defined as the drilled wells). No tap water was found in this area.

There method of excreta disposal is by using pit latrines and open fields, almost all the household have their own pit latrine for adults use while most of the children use open fields for defecation.

A pit latrine was selected from one of the household and was labeled pit latrine “A”. Two closest wells to this pit latrine were also selected, one being closer to the pit latrine than the other and were labeled well “A1” and well “A2”. The distances between pit latrine “A” and well “A1” as well as well “A2” were measured. The depths of the well “A1” and well “A2” were also measured and samples from these wells were taken to the laboratory for analysis.

A second pit latrine was selected in the same village but in a different location from the first one. This pit latrine was labeled pit latrine “B”. Two different closest wells to this pit latrine “B” were selected different from wells “A1” and “A2” and were labeled well “B1” and well “B2”, well “B1” being closer to pit latrine “B1” than well “B2”. The distances between pit latrine “B” and well “B1” and well “B2” were measured, the depth of these wells were also measured and samples were taken from each of this wells for laboratory analysis.

A third pit latrine was selected in the same village at a different location from both pit latrine “A” and “B” and was labeled pit latrine “C”. Two closest wells to this pit latrine “C” were selected and labeled well “C1” and well “C2”, well “C1” being closer to pit latrine “C” than well “C2”. The distances between pit latrine “C” and well “C1” and well “C2” were measured, the depths of the wells were also measured and samples were taken from each well for laboratory analysis.

A fourth pit latrine was selected in the same village at a different location from the previous ones. This pit latrine was labeled pit latrine “D”. Two closest wells were selected and labeled well "D1" and well "D2", well "D1" being closer to the pit latrine "D" than well "D2". The distances between pit latrine "D" and well "D1" and well "D2" were measured, the depths of the two wells were measured and samples were taken from the two wells for laboratory analysis.

The fifth pit latrine which is the last one for this project was selected in the same village at a different location from all the previous ones and was labeled pit latrine "E". Two closest wells to this pit latrine were selected and labeled well "E1" and well "E2", well "E1" being closer to the pit latrine than well "E2". The distances between pit latrine "E" and well "E1"and well "E2" were measured, their depths were also measured and samples were taken from each well for laboratory analysis.

All the ten samples that were taken from the ten selected wells (labeled A1,A2,B1,B2,C1,C2,D1,D2,E1 and E2) were taken to the laboratory for physical, chemical and biological analysis.

Questionnaires were administered to fifty selected household in the village to obtain information on the type of toilet facilities used, major source of domestic water, method of human waste disposal, whether drinking water is boiled before use and the perception of possible source of water contamination in the area. For the method of excreta disposal and water sources, the main method and sources were considered in instances where there was more than one method or sources respectively. The type of sanitary practices that takes places in the village was also observed.

CHAPTER FOUR

4.0 RESULTS AND DISCUSSION

4.1 RESULTS

4.1.1 Excreta Disposal

The majority of respondents (98%) said that adults used pit latrines whereas the rest said adults defecated indiscriminately. Similarly, a majority of respondents (70%) said that children used open field/defecate indiscriminately whereas 30% said children used pit latrines. Most of the pit latrines (95%) in the community were traditional, whereas the rest were ventilated improved pit latrines (VIP latrines). A walk through the community confirmed the report that some people excreted indiscriminately as human excreta was observed strewn all over the compounds.

4.1.2 Source of Domestic Water

Most people (85%) said they used shallow wells as the major source of domestic water, whereas (15%) said they used water from deep wells. The shallow wells often had no concrete slab and often the aperture was not covered at all or was poorly covered with a loose lid that was not lockable, whereas the deep wells had a piped system. Those who used deep wells were mainly the more affluent people in the community who often owned the plot in which the well was situated. Respondents who do not use deep wells water (bore-hole) complaint that the nearest wells is too far from their homes.

4.1.3 Distances Between Pit Latrines and Wells

The wells were very close to the pit latrines. In many circumstances (79%), the distance between the wells and the pit latrines was estimated to be less than 15 m (the commonly used guideline is that the distance should be at least 15 m). very few of the wells (about 21%) were estimated to be at a distance between 15 and 30m from the pit latrines. The distances between the pit latrines and wells from which samples were taken, their depths and the nature of each well is given in the table below.

Table 4.1: Locations, Distances and Depths of Ten Shallow Wells.

S/NO	LOCATION	DISTANCE FROMPIT LATRINE (m)	DEPTH OF EACH SHALLOW WELL (m)
1	A1	6.6	8.1
2	A2	14.2	8.9
3	B1	7.3	8.3
4	B2	15.4	7.8
5	C1	9.1	8.5
6	C2	19.7	7.4
7	D1	5.5	7.1
8	D2	13.5	7.9
9	E1	6.3	8.1
10	E2	14.9	7.9

4.1.4 Water Analysis Results

Ten water samples were analyzed, all of this ten samples were from shallow wells and all the samples were positive for total coliforms. The table below summarizes the results.

Table 4.2: Results of Water Samples Analyzed.

S/No	PARAMETERS	A1	A2	B1	B2	C1	C2	D1	D2	E1	E2	NSDWQ
1	Total Hardness ($mg/CaCO_3/l$)	93	94	86	114	113	143	84	118	66		150
2	Calsium hardness (mg/l)	76	79	70	97	91	112	57	89	54	46	N.S
3	Magnesium Hardness (mg/l)	17	15	16	17	22	31	27	29	12	18	N.S
4	Ca^{2+} (mg/l)	30.5	31.7	28.1	38.9	36.5	44.9	22.8	35.7	21.6	18.4	N.S
5	Mg^{2+} (mg/l)	4.15	3.66	3.90	4.15	5.37	7.56	6.59	7.08	2.93	4.39	0.2
6	Total Alkalinity ($mg\ CaCO_3/l$)	73	78	48	81	70	88	72	66	54	47	N.S
7	Electrical Conductivity (us/cm)	270	290	260	360	350	410	230	320	200	190	1000
8	Total Dissolved Solids (mg/l)	130	150	120	190	180	210	110	160	100	90	500
9	Nitrite (mg/l)	56.1	41.9	45.1	41.9	51.3	100	35.4	57.0	31.3	25.6	50
10	Nitrate (mg/l)	0.05	0.01	0.00	0.14	0.07	0.07	0.02	0.02	0.04	0.01	0.2
11	Sulphate (mg/l)	22	20	20	29	25	28	23	28	16	12	100
12	Colour (Pt.Co.)	6	9	35	21	11	14	81	8	18	25	15
13	Turbidity (FTU)	2	2	2	4	3	4	15	2	3	5	5
14	Suspended Solids (mg/l)	0	0	0	1	0	0	19	0	2	2	N.S
15	Iron (mg/l)	0.34	0.28	0.43	0.31	0.52	0.75	0.12	0.14	0.09	0.07	0.3
16	Total coliform cfu/100ml	55	43	47	57	60	67	120	34	92	87	10
17	E. Coli cfu/100ml	23	27	20	30	28	27	51	19	37	41	0

NSDWQ: Nigeria Standard for Drinking Water Quality (Standard Organization of Nigeria 2009).

4.1.4.1 Total Hardness ($Mg/CACO_3/L$)

The standard for total hardness is given to be 150 and the samples that were recorded gave numbers below the requirement. The maximum and minimum numbers that were recorded are 143 and 66. Total hardness is defined as the sum of the concentration of the calcium and magnesium ions,. It makes water unsuitable for domestic use. Magnesium concentrations greater than 125 mg/l may have a laxative effect on some people.

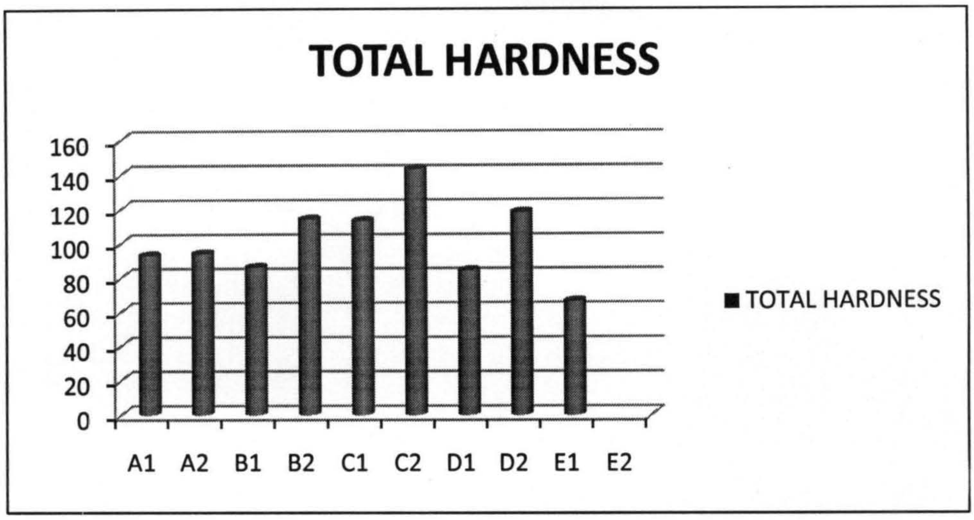

Fig.4.1: Variation in Total Hardness of ten water samples.

4.1.4.2 Calcium Hardness (mg/l)

The standard for calcium hardness is not stated in the Nigeria standard for drinking water quality. The maximum and minimum values obtained from the analysis are 112 and 46 respectively. The presence of calcium contributes to the hardness of water which makes it unsuitatable for domestic and industrial use. Treatment for calcium includes ion exchange through tank media and reverse osmosis.

4.1.4.3 Magnesium Hardness (mg/l)

The maximum and minimum values for magnesium hardness are 31 and 12. The Nigeria standard for drinking water quality is not stated. Also the presence of magnesium contributes to the hardness of water. Undesirable effects from the ingestion of magnesium in drinking water may result indirectly from the laxative effect of magnesium in association with the sulphate ion. As well, magnesium may contribute undesirable tastes to drinking water. Magnesium levels can be controlled through distillation.

4.1.4.4 Calsium Ion (mg/l)

The maximum value for calcium ions recorded from the samples is 44.890 while the minimum is 18.437. The Nigeria standard for drinking water quality for calcium ion is not stated. Adverse effects of calcium are observed only following the intake of extremely large quantities of calcium.

4.1.4.5 Magnesium Ion (Mg/l)

The Nigeria standard for drinking water quality for the presence of magnesium ion is given to be 0.2. The presence of magnesium ions recorded are 7.564 maximum and 2.928 minimum which are far higher than the required values.

4.1.4.6 Total Alkalinity (mg/$CaCO_3$/L)

The Nigeria standard for drinking water quality for total alkalinity is not stated. The maximum and minimum values recorded from the samples are 88 and 47 respectively. Alkalinity is a measure of the capacity of water to neutralize acids. Water may have a low alkalinity rating but a relatively high pH or vice versa, so alkalinity alone is not of major importance as a measure of water quality.

4.1.4.7 Electrical Conductivity (us/cm)

The electrical conductivities of the water samples were high with the minimum value being 190 and the maximum value being 410. The Nigeria standard for drinking water quality for conductivity is given to be 1000. Conductivity is a measure of the conductance of an electric current in water. Treatment with reverse osmosis is effective for drinking water purposes.

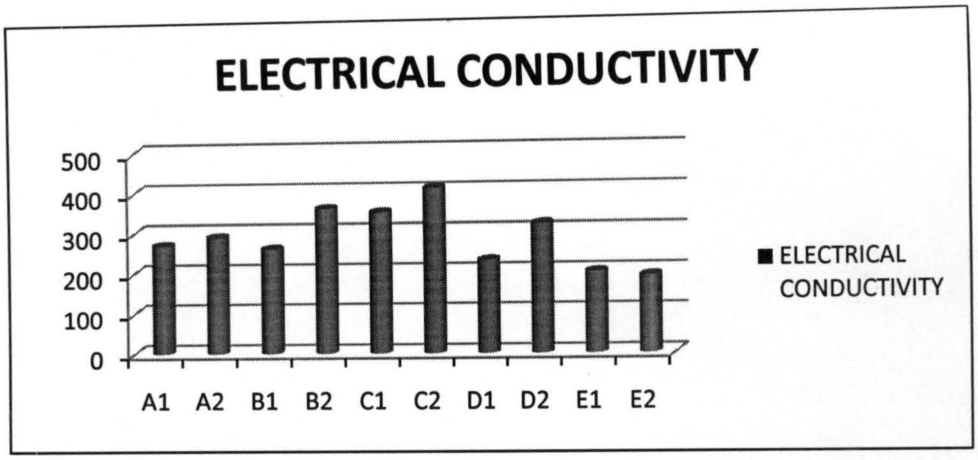

Fig.4.2: Variation in Electrical Conductivity of ten water samples.

4.1.4.8 Total Dissolved Solids (mg/l)

Total dissolved solids for Nigeria standard for drinking water quality is given to be 500. The minimum recorded from the sample is to 90 while the maximum is 210 which are too low for drinking water quality. The term total dissolved solids refers mainly to the inorganic substances that are dissolved in water. The effects of TDS on drinking water quality depend on the levels of its individual components; excessive hardness, taste, mineral depositions and corrosion are common properties of highly mineralized water. High concentrations of TDS may affect taste adversely and deteriorate plumbing and appliances. Treatment for household use is reverse osmosis.

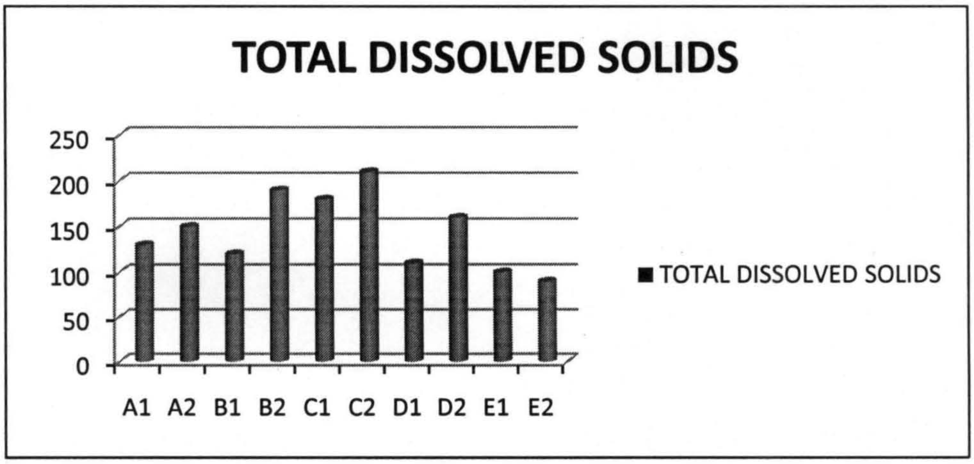

Fig.4.3: Variation in Total Dissolved Solids of ten water samples.

4.1.4.9 Nitrate and Nitrite (mg/l)

The Nigeria standard for drinking water quality for nitrate is given to be 0.2. the maximum value recorded from the samples is 0.000 and the minimum value is 0.07844 which are close to the required standard while The Nigeria standard for drinking water quality for nitrite is given to be 50. The minimum and maximum values recorded are 25.64 and 100.78 which are too low drinking water quality. When an infant takes in nitrate, it's converted into another compound called nitrite. High nitrate levels may cause methemoglobanemia (infant cyanosis or "blue baby disease") in infants who drink water or formula made from water containing nitrate levels higher than recommended. Adults can drink water with considerably higher concentrations than infants without adverse effects. Livestock water can contain up to 100 mg/l of nitrate-nitrogen, but young monogastric animals, such as swine, may be affected at nitrate levels of considerably less than 100 mg/l. Treatment of such water includes anionic ion exchange, reverse osmosis, distillation and/or deionization.

4.1.4.10 Sulphate (mg/l)

The Nigeria standard for drinking water quality for sulphate is given to be 100. The values recorded from the sample are 12 minimum and 29 maximum which is far too low or drinking water quality. Sulphat is one of the least toxic anions. The major physiological effects resulting from ingesting large quantities of sulphate are catharsis and gastrointestinal irritation. These effects are enhanced when sulphate is consumed in combination with magnesium. . Treatment includes reverse osmosis.

4.1.4.11 Colour (Pt.Co.)

The requirement for colour in the Nigeria standard for drinking water quality is given to be 15 but the values recorded from the samples taken ranges from 6 minimum to 81 maximum which are below and above the required value. Color may be indicative of dissolved organic material, inadequate treatment, high disinfectant demand and the potential for the production of excess amounts of disinfectant byproducts. Inorganic contaminants, such as metals, are also common causes of color.

4.1.4.12 Turbidity (FTU)

The Nigeria standard for drinking water quality for turbidity is 5 and only well "E2" had a value of 5. The remaining samples had values that were either below or above the required value with the minimum value being 2 and the maximum value being 15 which is too high for drinking water quality.Turbidity is suspended biological, inorganic and organic particles in water which may be in sufficient amount to make the water seem cloudy. Turbidity is a unit of measurement of the degree to which light traveling through a water column is scattered by the suspended organic (including algae) and inorganic particles. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU). Treatment includes mixing with a substance such as alum that causes coagulation of the suspended materials followed by sand filter filtration

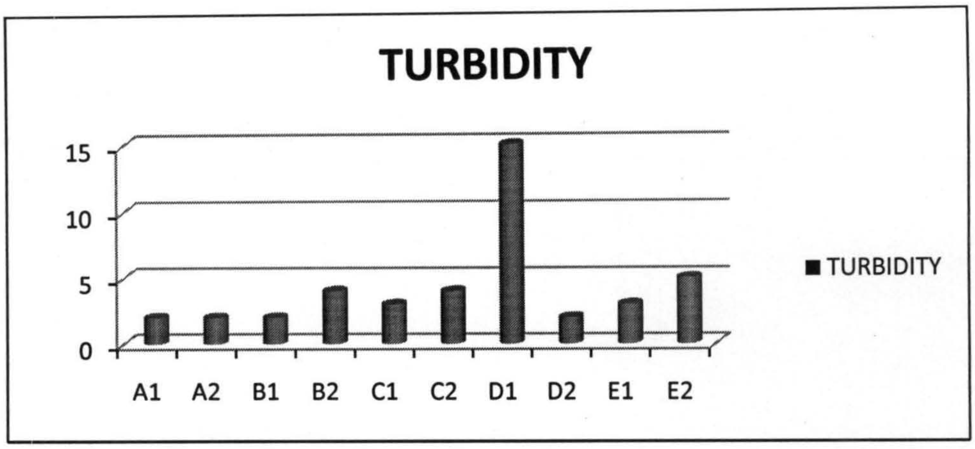

Fig.4.4: Variation in Turbidity of ten water samples.

4.1.4.13 Suspended Solids (mg/l)

The suspended solids required value for Nigeria standard for drinking water quality is not stated. The maximum number of suspended solids recorded was 19 and the minimum was 0.

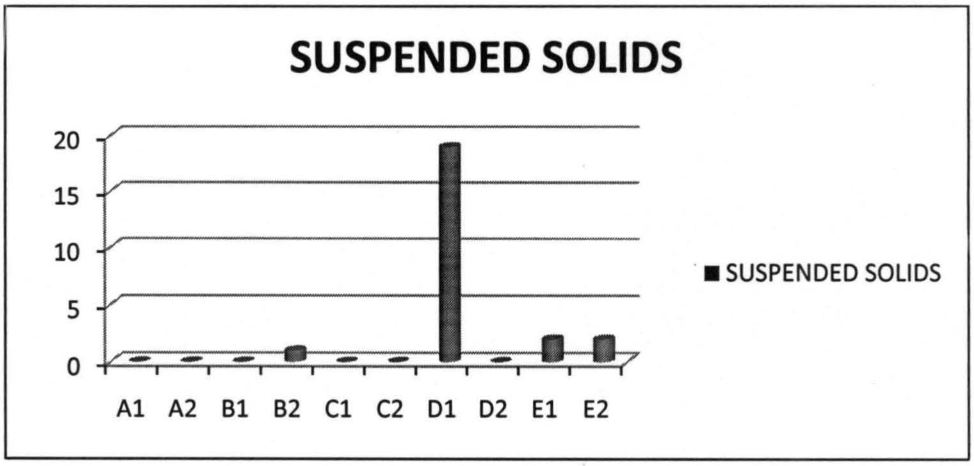

Fig.4.5: Variation in Suspended Solids of ten water samples.

4.1.4.14 Iron (mg/l)

The Nigeria standard for drinking water quality for iron is given to be 0.3. The minimum recorded from the samples is 0.754 and the maximum is 0.123. may cause brown and black stains on laundry, plumbing fixtures and sinks. A metallic taste also may be present and it may affect the taste of beverages made from the water. High concentrations of iron do not appear to present a health hazard. Treatment includes a water softener or iron filter for iron.

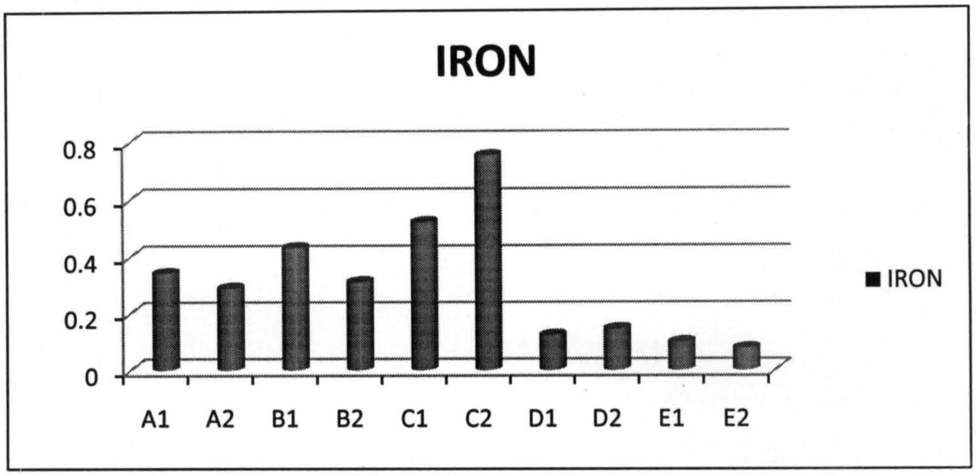

Fig.4.6: Variation in Iron of ten water samples.

4.1.4.15 Total Coliform (cfu/100ml)

The Nigeria standard for drinking water quality for total Coliform is given to be 10. All the samples were positive for total coliform with the minimum value of total coliform being 34 and the maximum being 120 which is too high and makes the water unacceptable for drinking.

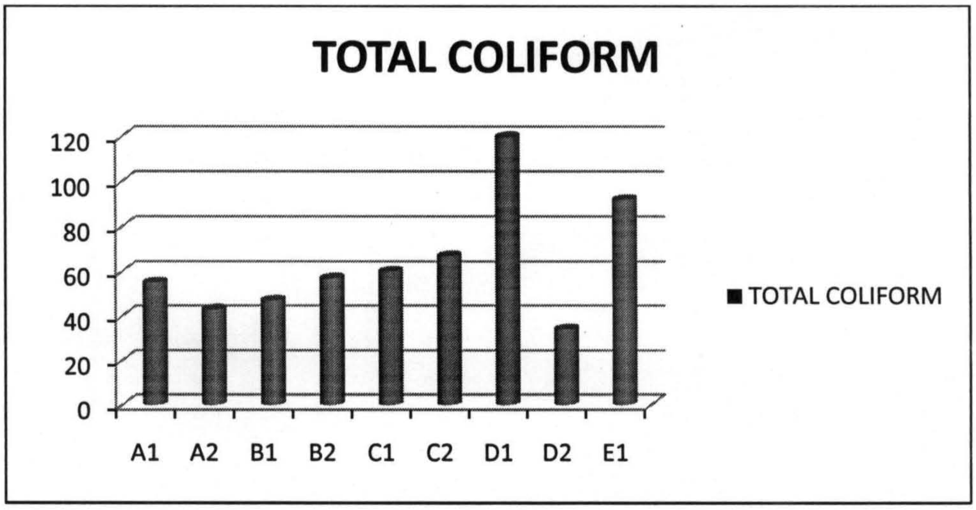

Fig.4.7: Variation in Total Coliform of ten water samples.

4.1.4.16 E. Coli (cfu/100ml)

The presence of E.coli in any water intended for drinking indicates the presence feacal contaminants which are harmful to human being. All the samples tested positive for E.coli with the minimum value being 19 and the maximum value being 51 which is too much and extremely dangerous for human comsumption.

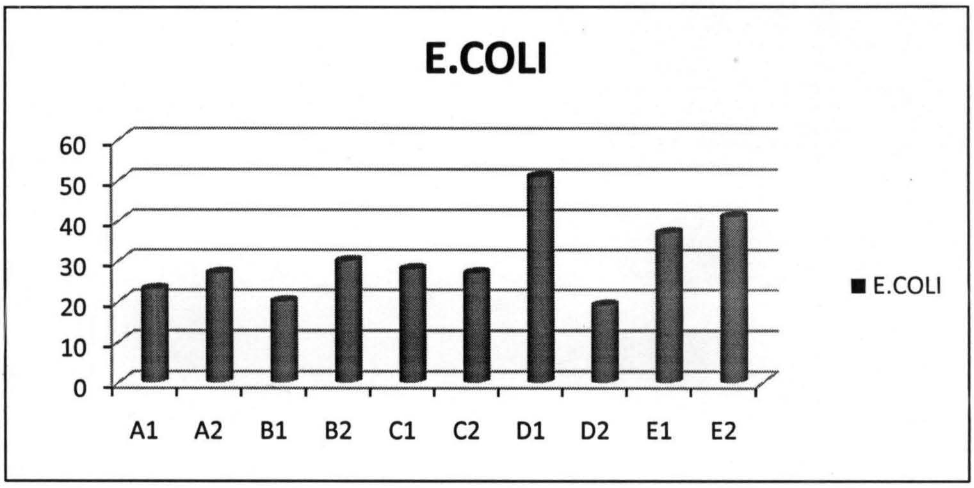

Fig.4.8: Variation in E.Coli of ten water samples.

4.1.5 Boiling of Drinking Water

Despite the short distance estimated between the pit latrines and the wells and the poor sanitary practices like indiscriminate excreta disposal, only 15% of those who reported using wells said they boiled their drinking water, when asked if they did.

4.1.6 Residents Perception of Contamination

Respondents pointed out various possible sources of contamination of the water sources in the area. These included children dipping dirty objects into water source (34%) as the main source of contamination, drawing water from the source with dirty containers (27%), domestic animals defecating around water sources (19%), and people washing clothes (5%) at the water source.

Interestingly, no one mentioned closeness of the well to the pit latrines as a possible source of contamination.

4.2 DISCUSSION

This paper provides evidence on the extent of contamination of main domestic water sources in the rural areas and suggests the most probable sources of this contamination. The evidence reveals that the most probable sources of contamination are hardly mentioned among the many sources perceived to contaminate the water sources by the residents of the village, which impacts how interventions ought to be developed.

The results indicate that the majority of the community members used pit latrines and at the same time used wells as the major source of domestic water. The conditions found in Kuchi do not fulfill the recommendations given for coexistence of onsite sanitation and use of ground water for domestic purposes, which indicate that there should be an adequate lateral separation between the pit latrine and the well to reduce chances of fecal contamination of the ground water. The distance between the wells and the pit latrines was estimated to be generally short with nearly 80% of the pit latrines estimated to be at a distance of less than 15 m from the wells. This raises the risk of contamination of the water sources as coliforms migrate from the pit latrines to the wells.

The presence of indicator organisms (*Escherichia coli* or thermotolerant coliform bacteria) in water indicates recent contamination of the water source with fecal matter and hence possible presence of intestinal pathogens. According to World Health Organization (WHO) guidelines, *E. coli* or thermotolerant coliform bacteria should not be detectable in any water intended for drinking. The laboratory analysis results of water samples in this study show that fecal matter heavily contaminated the water sources and especially the shallow wells. None of the shallow wells met the WHO requirements for water intended for drinking.

The presence of indicator organisms in the water samples collected from the wells indicates the coliforms migrated from fecal matter in the pit latrines through the soil to the water sources, facilitated by the very short distance between the pit latrines and the wells

Poor sanitary practices are also likely sources of pollution of the water sources. Sanitary practices were found to be generally poor from observation and from responses from the respondents. 80% of children excreted indiscriminately and consequently there were a lot of indiscriminately disposed excreta observed.

Rains are likely to wash off indiscriminately disposed excreta into shallow wells particularly if the wells are not protected. Therefore, this may have also contributed to the contamination of the generally open shallow wells with fecal matter. Other studies have also attributed contamination of water sources to wet seasons. Despite the contamination of water, it was evident that it was not a common practice for the slum dwellers to boil the water.

kuchi is not the only area with the problem of safe drinking water, other rural and some urban rural of the developing world have experienced similar problems. If the Millennium Development Goals of reducing by half the proportion of people without sustainable access to safe drinking water by 2015 and achieving a significant improvement in lives of at least 100 million rural dwellers by 2020 are to be met, there is a dire need for reconsideration of the rural areas in the developing world as far as water supply is concerned, as these rural are home to about 70% of all urban residents in Africa.

However, improving the water quality at source alone may not be the ultimate solution because improving water quality at source may not always ensure a reduction in the transmission of water-related diseases. Studies have shown significant deterioration in water quality between the source and the point of use. Esrey concluded that improving water had no health impact if the sanitation was not improved and that improving both water and sanitation together were synergistic in producing larger impacts than either alone.

Although the results of this study suggest the need for provision of safer water sources, in this community and in many other rural communities with evident poor sanitary practices, intensive behavioral change on sanitary practices is also paramount as this has been found effective in the reduction of water-borne diseases elsewhere. Whereas the findings from this study are worthwhile and should act as an eye opener for the situation of quality of water in the rapidly growing informal settlements in kuchi and in the rest of africa, more sampling of different water sources is highly recommended.

CHAPTER FIVE

5.0 CONCLUSION AND RECOMMENDATIONS

5.1 CONCLUSION

It is evident that most it the sources of domestic water in Kuchi village are contaminated with fecal matter and do not meet the Nigeria standard for drinking water quality and the world health organization guidelines for drinking water quality. This poses a health hazard to the resident of the village as they are at risk of water borne diseases. The results of this study also suggest that bore-holes and tap water may be safer, but additional sampling is needed.

The ideal intervention in the long-run may therefore be the provision of adequate piped water to all village dwellers. However this may take some time and simpler interventions could be put into place in the mean time. Basic sanitary improvement may be worthwhile at the moment, covering the shallow wells and possible installing hand pumps or mechanical pumps at the wells could improve the situation.

Basic treatment of the water at the community or household level by chemical disinfection using chlorine, filtration using simple household filters and boiling of water before use should also be promoted. These interventions may have a great impact on the health of the village drivellers as access to safe drinking water and basic sanitary services are very important and prevent the dangers of water-borne- diseases.

5.2 RECOMMENDATIONS

Based on the laboratory analysis carried on ten samples taken from ten shallow wells in Kuchi village, it was observed that the closer the wells are to the pit latrine (on-site sanitation), the higher the rate of contamination. Therefore it is recommended that

(i) The minimum distance between a pit latrine (on- site sanitation) and water wells should not be less than 15m.

(ii) All the surroundings of the wells should be kept clean (no form of waste disposal should be kept close to the well).

(iii) All the wells should be provided with good covers, good lining and aprons.

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