IMPACT OF IRON AND MANGANESE LEVELS OF SWASHI IRRIGATION SCHEME WELL WATERS

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POSTGRADUATE DIPLOMA(PGD) IN SOIL AND WATER ENGINEERING

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BY

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SEPTEMBER, 2004.

CERTIFICATION

This is to certify that the project titled “Impact of iron and manganese level in Swashi irrigation scheme well waters” was carried out by Samaila Umaru Saidu (PGD/AGRIC ENG/2001/134) and approved as being adequate in scope and quality meeting the requirement for the award of Post Graduate Diploma (PGD) in Soil and Water Engineering, Federal University of Technology, Minna.

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ACKNOWLEDGEMENT

All glories are to the Almighty Allah, the most compassionate who has made it possible for me to complete this work.

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ABSTRACT

Monitoring of iron and manganese levels in well waters of Swashi Irrigation area was carried out during the dry season of 2003/2004. The mean level of iron and manganese were found to be 0.87mg/L and 0.418mg/L respectively. This level of iron far exceeds the WHO Secondary Drinking Water Standard, maximum permissible level of 0.3mg/L, while the level of manganese could affect the taste and odour properties of the water. This implies that the water is not suitable for domestic use. The impacts of this low quality water were discussed and ways of making the water potable and suitable for other domestic use were suggested. The availability of potable water in this area will no doubt increase the capacity utilization of the irrigation project.

CHAPTER ONE

1.0 INTRODUCTION

1.1 INTRODUCTORY NOTES

Water is an essential element for man's life; water is everywhere, about 97%of the earth's water is in sea and oceans, only 0.6%is available for man and vegetation use. The 0.6%is available in form of fresh water lakes, rivers, soil moisture or groundwater, so we don't have water, world wide, the same thing happen to people surrounding Swashi irrigation scheme area especially during dry season, they have to look for underground water by means of wells. These wells should normally contain potable water. Potable water is one that can be used for drinking purposes with safety and satisfaction. It is therefore essential that such a supply must be of very high quality with the following characteristics:

1- Free from pathogenic organisms

2- Colorless or at least possesses no turbidity that can repel the consumer.

3- Free from compounds capable of causing harm to the consumer, such Fe, Mn, e.t.c.

4 -Neither corrosive in nature, nor capable of staining laundry.

Groundwater is an important source of potable water for rural and medium sized communities in Nigeria. Many favour groundwater over surface water because of its excellent and consistent quality, and because, generally, it require little or no treatment. Unfortunately, many groundwater supplies, including the well waters of Swashi Irrigation scheme area are contaminated by varying levels of iron and manganese in concentrations that exceed the WHO drinking water secondary guidelines.

The Swashi River Irrigation project is located in the Borgu area of Niger state Nigeria. It falls between latitude 10^0 20' and 10^0 30' N and longitude 4^0 20'E. The scheme consists of net irrigation area of 2900hectares on the west bank of Kainji Lake. A storage reservoir called Kubli, created by a concrete dam in Kubli hill gorge, across Swashi River regulates the river flow. Regulated releases from the reservoir are intercepted at Swashi Diversion Dam 13km down stream of Kubli Dam.

The project area has a low population density due to poor infrastructural facilities. The dam which has about 60Mm^3 of impounded water is capable of providing domestic water supply to Swashi and other neighboring communities, however the necessary reticulation facilities were not provided. Fig 1 shows the location of the Swashi Irrigation Scheme area.

People surrounding Swashi Irrigation project area use water from wells for their domestic activities especially during the dry season, these wells should normally contain potable water. Potable water is one that can be used for drinking and other domestic purposes with safety and satisfaction.

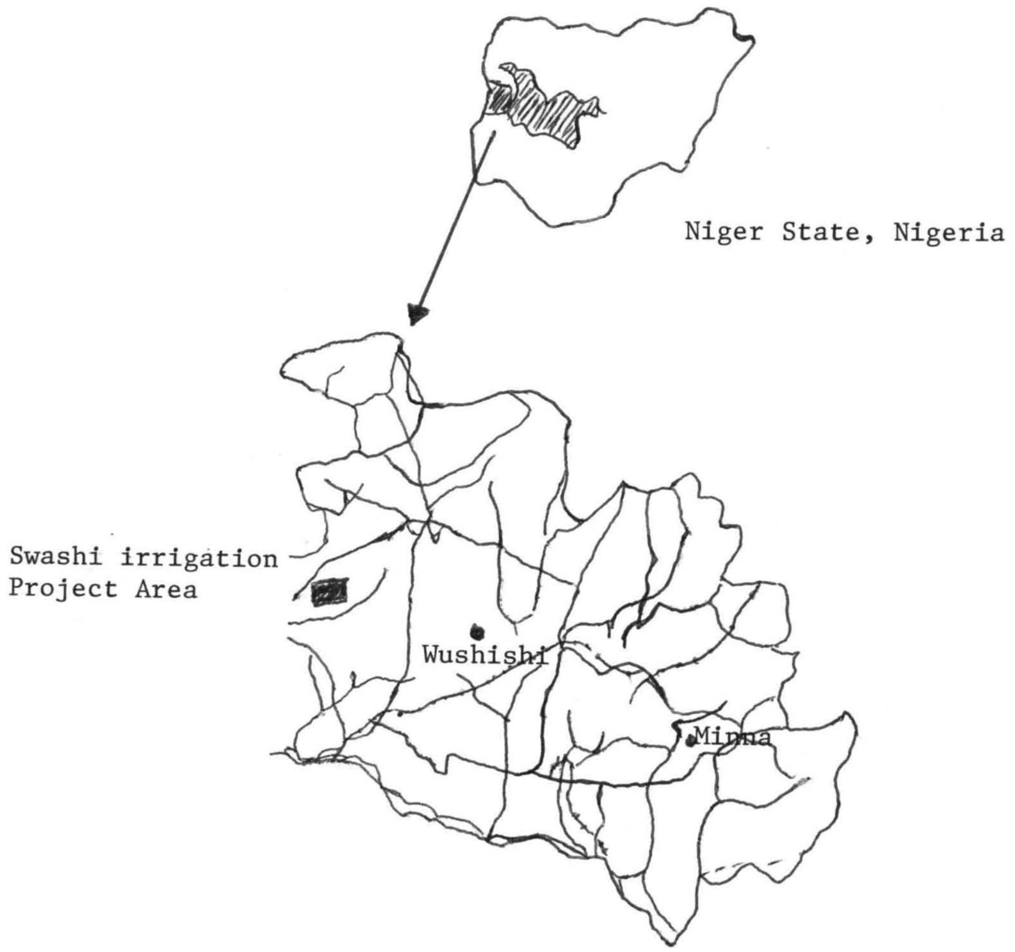

Fig 1: Map of Niger State showing the location of Swashi irrigation Area Project Area

1.2 DESCRPTION OF PROJECT AREA

1.2.1 CLIMATOLOGY

The Swashi Irrigation scheme area is in Borgu Local Government of Niger State in The Middle Belt of Nigeria (Southern Guinea Savanna). It has an annual rainfall ranging between 1200mm and 1300mm, with peak rainfall in August. The temperature of the area varies from 19.73°C to 37.32°C; and the climate has excessive humidity during greater part of the year. The hottest periods are the months of February, March, and April of every year, during this period, people of that area use underground water to sustain their life.

1.3 AIM

The aim of this project is to monitor the levels of iron and manganese in wellwaters of Swashi irrigation scheme area and determine the impact of their concentration on the community. The specific objectives are:

- To assess the concentration of iron and manganese and their variation in underground water of Swashi irrigation area.
- To determine whether the affected ground water of Swashi irrigation area satisfies the W.H.O quality standard.
- To determine the effects of their concentration.
- To recommend ways of preventing the impact.

1.4 JUSTIFICATION

People around the community have been complaining of water problems, particularly their wells that the water stain their laundry and sometimes have odour. The fact that from literature excessive iron and manganese concentration causes this impact to water quality, that is why this work is trying to examine the concentrations of these elements in Swashi well waters. During the dry season surface water are rarely found making underground water the only available source of water. Determination and analysis of these chemicals in Swashi well waters (Fe, Mn) will be of great importance.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 WATER QUALITY

Water quality is determined by the concentration of biological, chemical and physical contaminants. Most water pollution is the result of human activities. Biological contaminants result from human and animal waste plus some industrial processes and agricultural use of fertilizes and pesticides. Physical contaminants result from erosion and disposal of solid waste. Since these entire sources contribute to degradation of water quality, Standard has been developed for ~~by~~ drinking water by U.S. Public Health Service (table1). These standard strikes to prevent health problem by defining the quality of water available for human consumption. Many Local, State and Federal regulations have been -instituted to prevent contamination of both surface and ground water supplies.

Sources of water pollution are recognized as point or non-point in origin. Point sources include animal feedlots, chemicals dumpsites, storm drain and sewer outlet, acid mine outlet; industrial waste outlet and other identifiable point of origin. Non-point sources include runoff from forest and agricultural land, hillside, seepage, small sub surface drain outlet and other diffuse sources ·non-point pollution is often more difficult to identify and to correct.

Table 1: Drinking water standard.

A. Chemical

1 Maximum Contaminant	Level (mg/l)
Arsenic	0.05
asbestos[a]	-
Barium	2
Cadmium	0.0005
Chromium	0.1
Lead	0.05
Mercury	0.0002
nitrate (as N)	10
nitrite (as N)	1
Selemium	0.05
Alachlor	0.002
Aldicord	0.003
Atrazine	0.003
Carbofuran	0.004
Chlordone	0.002
Endrin	0.0002
ethylene debromide	0.00005
Heptgachlor	0.004
Lindone	0.0002
Metoxychlor	0.04
Toxaphene	0.005
total tritholonethanes (THMS)	0.1

2 Secondary Maximum Contaminant	**Level (mg/l)**
Chloride	250
Copper	1
Fluoride	2
Iron	0.3
Manganese	0.05
Ph	6.5 to 8.8
Sulphate	250
total dissolved solid (TDS)	500
Zinc	5
A. Physical	
Color	15 collor unit
Odor	3 odor unit
C. Bacteriological	
coliform bacteria	none

NB. [a] 7 million fibers (longer than 10mm)/l

Source, WHO (1996)

2.2 BIOLOGICAL CONTAMINANTS

In agriculture, biological contaminants are primarily from animal and human waste. Feedlots, dairies and septic systems are major sources of biological; pollution. Bacteria are the most common organisms, however viruses and other microorganism may also be present and all can create serious health problems. Biological contamination can be controlled by proper disposal of waste, separation of septic system, feedlots and other source of drinking and surface water supplies and treatment of drinking water before consumption.

2.3PHYSICAL CONTAMINANTS

The most common physical contaminant of water is suspended sediment. Other physical contaminants include organic materials such as plant residues. Most sediment occurs because of soil erosion, however sand may be obtained during pumping from wells.

Where sediment is deposited on sandy soil, the textural composition and fertility may be improved, however if the sediment has been derived from eroded areas. It may reduce fertility or decrease soil permeability. Sedimentation in canals or ditches may be serious resulting in higher maintenance costs. Eroded sediments not only indicate an erosion loss, but carry attached chemical ions such as phosphorus and potassium, which contribute to chemical pollution as well. These chemical cause entrophication in lakes and streams, increase the cost of treatment for domestic and industrial supplies and adversely affect fish and other aquatic life.

2.4 CHEMICAL CONTIMINANTS

Chemicals are major source of water contaminations; some chemicals occur naturally in water others are introduced during water movements through geological materials but most problems are caused by manufactured chemicals. Fertilizers and pesticides are the major contributors to chemical pollution from agriculture. These chemicals may be applied to soil or foliage over large areas and hence become potential sources of non- point pollution, however, fertilizers and pesticides have contributed to a high quality abundant food supply to reasonable cost for the people of United States and for export. (Glenn.O. Schwab, 1992)

2.5 GROUND WATER IMPACTS

Agricultural pollution can also cause serious ground water contamination problems. Ground water pollution can arise from both point and non point sources (Canter et al, 1997). Agricultural non- point pollutants include nutrients (particularly nitrates), pesticides, mineral salts, and heavy metal and disease pathogens. Agricultural contamination entering ground water via abandoned well, pesticides spills or disposal area may constitute point source, and this to say agricultural points is relatively rare. Ground water contamination effects are quite similar to off stream impacts of nutrient, pesticides and mineral salt contamination of surface water. These contaminations create serious health concerns in drinking water cause corrosion and chemical reaction problems in domestic and industrial water uses, and can affect the productivity of irrigated lands.

There are no adequate data available on a national or inter national scale to estimate the extent of ground water contamination or to assess the impacts of this contamination. It is extremely difficult and expensive to ascertain the potential damages associated with various contamination and mixture of contaminants. Nielson and Lee (1987) estimate that first time monitoring cost for

50 million people in United State that depend on ground water would range from $1.0 billion to $2.3 billion. However more than 60 pesticides have been detected in under ground water in 30 States many at concentration believed to cause serious chloric health effects (Ziun, 1988). These contamination incidents although relatively isolated, along with the general level of uncertainty surrounding the extent and potential effects of contamination have created deal of concern over the safety of ground water supplies and increase in government activity aimed at ground water quality protection. The EPA is currently testing for 125 pesticides in a nationwide sample of 1,300 drinking-water wells (water quality John. B. Broden, 1990).

2.6 CHEMICAL EXAMINATION OF WATER

Chemical composition of surface water depends on the characteristic of the catchments. Ground water acquires the characteristics of the soil through which it flows. The common chemical pollutants, which are of importance in water, are indicated in table 2 below.

TABLE 2 : Title

Pollutant	Pollutant	Pollutant
Calcium(Ca ++)	Dissolve salt (anion)	Alkalinity,Acidity
Magnesium(Mg++)	"	Hardness
Iron (Fe++)	"	Hardness, colour, taste
Bicarbonate (HCO_3^-)	dissolve salt (cation)	Hardness colour
Carbonate ($C03^-$)	"	Alkalinity

Sulphate ($So4^{-}$)	"	"
Chloride (Cl)	"	Lascative
Fluoride (Fl^{-})	"	Taste
Organics	"	Tooth motting colour
Gases O_2	disolve gases	Corrosion,oxidation
CO_2	"	Acidity
H_2S	"	Acidity,reducing agent

Source: A. Kastalsky,1989

2.7 EFFECTS OF IRON AND MANGANESE ON QUALITY OF NATURAL WATERS

2.7.1 IRON AND MANGANESE

Iron and Manganese can be present in natural water in different forms, depending on the pH index and oxygen content. For instance iron may be present in the form of bi and trivalent ions, organic and inorganic colloids complex compound, fine-disperse suspension, iron sulphide or iron (II) hydroxide. In under ground waters, which are usually low in oxygen, iron and manganese are most often found as bivalent salt. In surface waters, they may be presented as organic complex compounds colloids or fine disperse suspensions. The concentration of iron and manganese in natural water usually does not exceed a few tens mg/l and only in waters of mines may be as high as a few hundreds mg/l or more. Long time consumption of drinking water with high concentration of iron can lead to liver disease (hemosiderosis). Iron-rich water has an unpleasant flavor and cause troubles in domestic use because of which the concentration of iron in potable water is limited to 0.3mg/l and that of manganese to 0.1mg/l (Nikoladze, 1989)

2.8 DEFERIZATION OF WATER

Iron in underground waters occurs in the form of dissolved Iron (II) carbonates, bicarbonates and complex Iron-organic compounds. In surface waters, it may be present in the form of colloidal and fine-disperse suspension and sulphite or as complex compounds.

Deferization of water is carried out by the following methods: deep aeration with subsequent settling and with the used of thin layer module and filtering; deep aeration in vacuum-ejection plant, followed with filtering in filter frame filters, simple aeration with reagent method wit preliminary aeration with the used of line or oxidants and subsequent thin layer or common filtering, filtering through modified filling, and cation exchange.

The choice of a method, flow diagram and plant for water deferrization depends on the form o f occurrence of iron in water and the required ~~throughput~~ output capacity. Deferrization of underground waters is usually carried out by methods without the use of reagents, surface waters are deferrized by reagents, since they should be simultaneously decolorized and clarified.

Aeration is the most popular method for deferrization of underground waters. The flow diagram of a plant for water deferrization by deep aeration usually includes an aerating device (vacuum-ejection apparatus, cooling tower, spray ponds, etc) contact settling reservoir (or contact filter) and clarifying filter. In the aeringe device, water is saturated with oxygen, part of carbon dioxide is removed and bivalent iron is partially oxidatized to trivalent form iron. In the contact reservoir, the process of oxidation to trivalent and result in the formation of flaky precipitate of iron hydroxide due to hydrolysis of trivalent iron. Iron hydroxide is separated form water in the filters. Aeration can be effected by various methods by feeling air into the in take pump, by air suction into a vacuum ejection apparatus; by injection of compressed air into water (through perforated pipes or porous plates); by spraying water in air (in spray ponds) or by passing water through the packing of a cooling tower. In the last case, the packing is made of plastic rings of the size 20×20×2 mm or ceramic Rasching 25×25×3 mm. The matter flow rate is 60 m^3/h and of that made of plastic rings 70 m^3/h with pH more than 6.8, hydrogen sulphide concentration is up to 0.5 mg/l water alkalinity more than 1+ $[Fe^{2+}]/28$ oxidability up to 0.15 (Fe^{2+}) +5 mg/l O_2, and iron concentration in water up to 10 mg/l deferrization can be carried by the method of simple aeration in which water is saturated with air when flowing from a height of 0.5-1.0 m into the pocket of an open filter or by introducing compressed air into the pipeline before pressure filters. It is preferable to employ filters with two layer filling: the; lower layer of quartz sand grain size 0.5-12 mm and thickness 500 mm and the upper layer of crushed anthracite of grain size 0.8-1.8 mm and 500 mm. The filtration rate is chosen so that it did not exceed 12 m/h when one of the filters is being washed. The intensity of washing is 12-15 l/sm^2.

2.9 DEMANGANIZATION OF WATER

Various methods have been developed and are now used for demanganization of water. Some of these methods are based on oxidation of ions of manganese (II) which are present in water, to manganese (III) and (IV). The lost two forms of manganese forms hydroxides hydroxides whose solubility at pH > 7 is less than 0.001mg/l. Various oxidants are employed for the purposes, such as potassium permanganate, ozone, chlorine and its derivatives, and atmospheric oxygen. Besides manganese can be removed from water by ion exchange processes (H and Na cation exchange), by the method of lime soda softening, by filtration of water through a manganese zeolite filling, by biochemical and others methods. The existing methods of water demanganization can be divided into reagent-less and those using reagents (oxidation, sorption, ion exchange and biochemical methods). The group of reagent-less methods includes: deep aeration with subsequent settling and filtration in clarifying rapid filters, vacuum ejection and filtering in rapid filters, viredox process and sorption of freshly formed iron by dioxide.

The reagent methods of water demanganization include oxidizing methods with the use of chlorine and its derivatives, ozone, potassium permanganate, and commercial oxygen, and methods based on the use of alkaline reagents.

For oxidation of bivalent manganese-to-manganese dioxide it is essential to maintain a definite oxidation reduction (redox) potential whose magnitude depends on the particular required concentration of residual manganese and the pH of the medium.

Removal of manganese from water by deep aeration is possible if the pH value of water upon removal of free carbon dioxide attains a value no less than 8.5; only under such conditions oxidation of manganese (II) ions is possible. In practice, however, deep aeration can only rarely ensure the required pH value, so that a need arises to add lime or soda to water. It should be noted that the filtration. This technology of demanganization is complicated and expensive and associated with certain negative effects for instance, the softening effect in water due to the formation of calcium carbonate and magnesium hydroxide required that suspended bed clarifiers or thin-layers settlers be additionally included into incrustation of sand grains the filing with calcium carbonate is possible.

Combined demanganization and deferrization of underground waters can be achieved by deep vacuum ejection degassing and aeration of water which increase the pH index of water and this is saturated with oxygen. This leads to the formation of iron by dioxide, which has a catalytic effect on oxidation of manganese (II) and sorbs the latter. The process than 8.5 and E greater than 0.4 V. The sorption nature of manganese extraction in this case is confirmed by an isotherm of adsorption plotted by the results of industrial experiments, which is adequate to Bedecker-Freundlich adsorption isotherm. In infiltration, the following processes take place. The surface of sand grains at pH = 7 has a low negative electric charge and therefore has weak sorption charge with an increase of pH the sorptivity of sand surface increases. In filtration through sand, the surface of grains first adsorbs ion of iron (II) and manganese (II). Under the action of dissolved oxygen, ion (II) ion is oxidized to iron (III), which is by dialyzed, and forms a new sorbent on the surface of grains. This new sorbent consists of iron compounds and can adsorb manganese (II) ions. Free carbon dioxide, which is dissolved in water, is also adsorbed by this sorbent thus lowering the pH index and worsening the effect of purification.

The most efficient and simple methods consists in the possibility is treatment with potassium permanganate .It is applicable at water purification station of many through put capacity and any quality of initial water use of manganese oxidation catalyst.

As has been established manganese oxides precipitated on the surface of grains of filter filling can produce catalytic effect on the process of oxidation of manganese (II) ions by the oxygen dissolved in water. When aerated and alkalinized water with a certain concentration of manganese is being filtered through a sand bed, a lager soon forms on the surface of sand grains, with consists of negatively charged precipitate of manganese dioxide $Mn(OH)_4$.This lager absorbs positively charged manganese (II) ions . Upon hydrolysis, these ions react with Mn $(OH)_4$ precipitate and form an easily oxidizable compound , Mn $_2O_3$ the reactions involved are follows:

$$Mn(OH)_4+Mn(OH)_2 \longrightarrow Mn_2O_3+3H_2O$$

$$2Mn_2O_3+O_2+8H_2O \longrightarrow 4Mn(0H)_4\downarrow$$

This, the final product of the reactions is manganese (IV) hydroxide which again participates as catalyst in the oxidation process. This property of manganese oxides can be utilized practically in the method of water filtering through a sand bed with grains precoated with films of manganese dioxide (black sand). For this purpose, common quartz sand is treated with potassium per manganese solution with the use of this filling in filter; oxidation of manganese by dissolved oxygen of water is possible at substantially lower values of pH then is usually possible $(pH>=7.5)$

2.10 EFFECTS OF EXCESSIVE IRON AND MANGANESE ON HOUSEHOLD WATER QUALITY

Standards for iron and manganese are based on levels that cause taste and staining problems and are set under WHO's secondary drinking water standards. For most individuals 0.3mg/L of iron and 0.05mg/L of manganese is objectionable, Bruce et al. (1992). Usually iron and manganese do not exceed 10mg/L and 2mg/L respectively in most natural waters.

Although they have no negative effects on human health and the established limits for these elements are only aesthetic objectives (AO), their presence in water can cause taste, colour, staining and accumulation problems.

Because iron and manganese are chemically similar, they cause similar problems. Iron cause reddish-brown staining of laundry, porcelain, dishes, utensils, water bottles and even glassware. Manganese acts in a similar way but cause brownish-black stain.

Iron and manganese deposits build up in pipelines, pressure tanks, water heaters, and water softeners. This reduces the available quantity and pressure of the water supply. There are also associated increased energy costs like pumping water through constricted pipes.

Long time consumption of drinking water with high concentration of iron can lead to liver disease (hemosiderosis). Iron-rich water has an unpleasant flavor and cause troubles in domestic use. Excessive concentration of manganese affects the organoleptic properties of water, particularly taste and odour (Nikoladze, 1989).

2.11 TREATMENT METHODS FOR IRON AND MANGANESE REMOVAL

The purpose of water treatment is to convert raw water to clear sparkling and pathogen and chemical free consumable resource. Water is also treated to remove iron and manganese which impacts taste and colour and cause staining of laundry.

Various chemical oxidants can be used to oxidize and precipitate iron and manganese from water, thus allowing them to be filtered. However, the rate of reaction is highly influenced by several factors including the concentration of the metal, the ph, the temperature of the water, the presence of inhibiting elements and or complex substances like humic acids, polyphosphate, and silica (O'Connor, 1971, Machmeier 1990).

Any of these factors can significantly slow the oxidation of iron and manganese by mineral oxidants or by specific catalyzing media, often an intense aeration with brief contact filtration will oxidize the iron and render it filterable by conventional filters. The oxidation of manganese by oxygen alone is very slow, but the reaction is catalyzed by the presence of previously oxidized manganese. The use of strong oxidants such as ozone and potassium permanganate allow the reaction to take place in a reasonable time.

There different types of treatment methods that are presently in use, include polyphosphate treatment, ion exchange, adsorptive/oxidative filtration, chlorination plus filtration. These conventional iron and manganese removal system have the following disadvantages.

They often require the use and handling of strong oxidants, they do not always produce a satisfactory effluent quality, and the filtration rates are limited, making the equipment large and expensive (Paul, 2002).

CHAPTER THREE

3.1 ADMINISTRATION OF QUESTIONNAIRES

Questionnaires were prepared and administered on selected people in the four villages, to know what the sources of their drinking water are during the dry season within the area of study (fig2.) the responses were collected and analyzed.

3.2 SAMPLING POINTS

Four sampling points were selected, two villages at upstream side and two others at the downstream side of the irrigation scheme.

UPS1- Upstream well, water sampling point one (1), the well is situated in Tungan Dari village (8meters deep). UPS2- Upstream well, water sampling point two (2) the well is situated in Kwalla village, the well is 8 m deep. DWS1- Down stream well, sampling point 1, the well is situated in Saminaka village with a depth of 8 meters. DWS2- Down stream well, sampling point 2.The sampling point is 8 meters deep, situated in Tungan Alhaji village. The two sampling wells in Saminaka and Tungan Alhaji villages were dug specifically for the purpose of this project as their villages do not have well that is less than 15meters deep and is not in conformity with the upstream wells, in order to have a reading that will not be affected by depth two uniform deep wells were dug at 8meters depth for the two downstream villages.

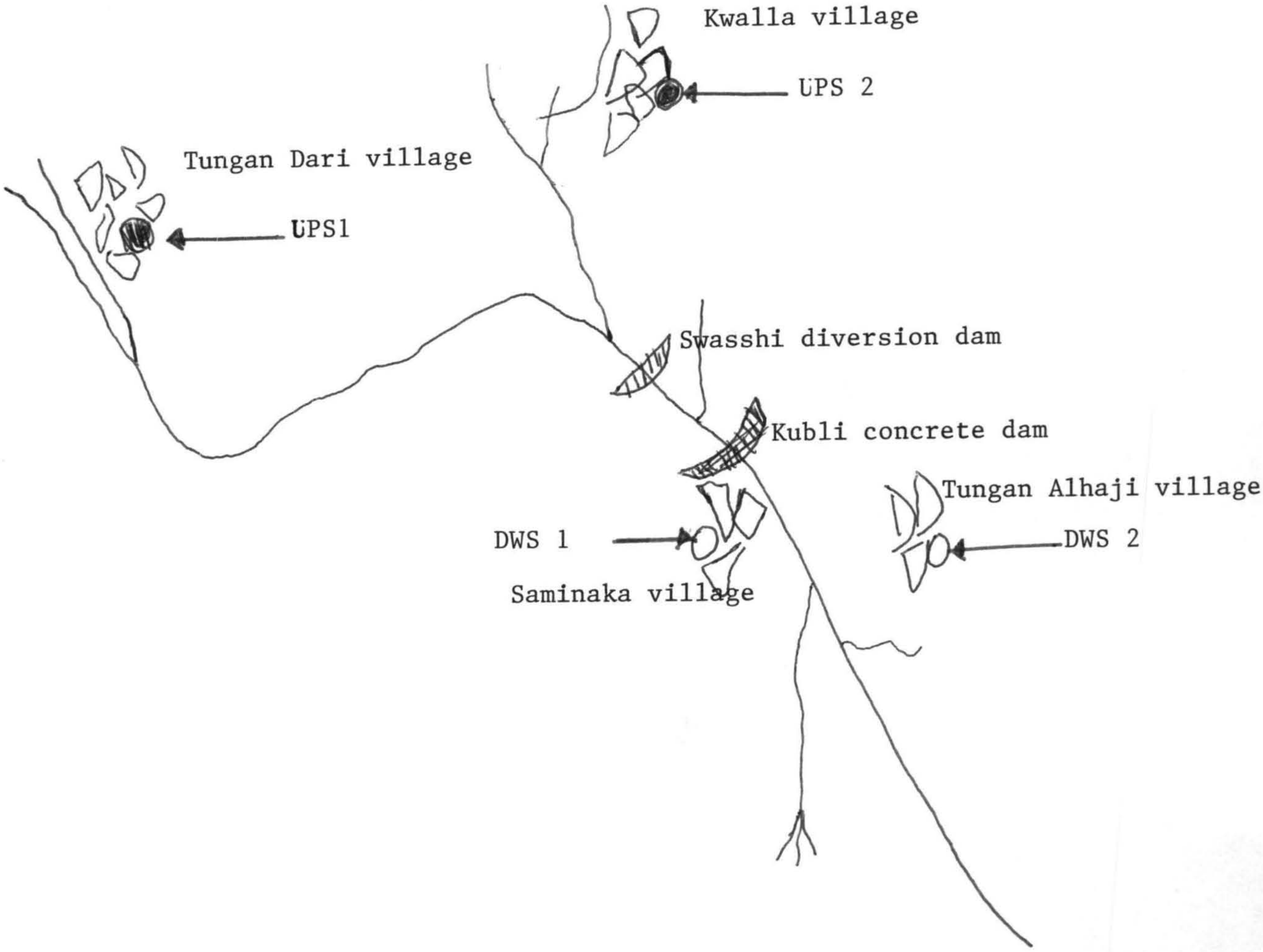

Fig 2: Sketch of Swashi irrigation area, showing the sampling points.

3.3 GENERAL SAMPLING ANALYSIS

Three general methods of quantitative determination are used in water analysis: gravimetric, volumetric and colometric.

The gravimetric method consist of separating simple substances from means, weighing each substance separately, and calculating the proportion of each substance with respect to the total sample. This method is generally used to determine the amount of suspended (undissolved) in the sample. It is also a convenient means for determining the total amount of dissolved solids but is more laborious than the other methods for determining the amount of each different mineral constituent.

The volumetric analysis is performed by adding to measured portions of the water sample the exact sample volume of standard strength of the chemical solution required to bring about a specific chemical change. The chemical change takes places as standard solution is added to the water being analyzed at ~~are~~ the end point of the titration. A few drops of certain colored chemical indicators such as phenolphthalein and methyl orange are usually added before bringing a titration and change in color of the indicator used shows the analyzed in the water is estimated directly from the volume of each standard chemical solution required.

The colorimetric analysis are those results ~~are~~ based on comparison of colors produced in the water sample with those of prepared standards. A most common colorimetric determination in water analyses is for iron. A given volume of water sample is treated with chemical reagents and iron is present the sample becomes colored. The color is compared with that of prepared containing known quantities of iron, thus determining within close limits the amount of iron percent in the sample.

The photometric water analysis is a precise photoelectric color-measuring instrument. It comprises of a constant voltage transformer a prefocused bulb a holder for precise optically polished glass cells and sensitive and reproducible disc containing accurately designed color filters. These filters serve to accentuate the instrument's ability to measure accurately the minute color differences. In addition to the major and minor elements the water analyzer is also used for determining the pH, turbidity and oxygen demand index of water samples.

3.4 PARAMETERS USED

i- Iron is analysed in water by spectrophotometric method..

ii- Manganese's level is determined by spectrophotometric method also.

3.5 METHOD OF ANALYSIS

3.5.2 SAMPLING

Sampling was done with plastic containers that were carefully corked with cellophane and kept in cold condition with ice blocks before reaching the laboratory.

3.5.2 IRON AND MANGANESE TEST

The level of these two elements were determined by spectrophotometric method in which an Atomic Adsorption Spectrometer (AAS) device. This device uses acetylene gas to bombard atoms; also for each element testing there is a specific lamp of that element that is put in the device to have the percentage level of that particular element.

When determining the level of iron and manganese the same process is done, we put respectively the iron and manganese lamps, while the samples were already in the device and we ~~red~~ read the different values of these elements in each sample through digital meter on the device.

Iron and manganese were analy~~k~~sed in the samples using a multiparameter spectrophotometer, with Iron analysed using Light Emitting Diode (LED) at 470nm, which is an adaptation of the phenantroline EPA recommended method 315B for natural and treated waters. The reaction between iron and reagents causes an orange tint in the sample. Manganese was analysed using LED at 555nm, this is an adaptation of the standard Methods for the Examination of Water and Wastewater, 18th edition, persulfate method. The reaction between manganese and reagents causes a violet tint in the sample. The results can be seen in next chapter.

CHAPTER FOUR

4.0 RESULTS AND DISCUSIONS

4.1 RESULT OF QUESTIONNAIRE ADMINISTRATION

100 people were questioned, with 25 persons interviewed per village. The result of the questionnaire indicate that 85% of the villagers around the Swashi irrigation area source their water from shallow dug wells during the dry seasons, the rest utilize the water from the canals of the irrigation scheme. 65% use harvested rain water during the rainy seasons from June to September, and substitute it with well water during the dry spell periods. They use the water for all their domestic activities (Drinking, cooking, washing, laundry, bathing etc)

All the villagers questioned complained about the quality of their well waters, 80% said it stains their garments during laundry, 65% said it affected the taste of their drinking water, while 95% complained about the objectionable colour that affected their appetite. A sample of the questionnaire is shown in appendix.

4.2 VARIATIONS IN IRON AND MANGANESE LEVELS IN SWASHI WELL WATERS

The variations in well water quality of Swashi area was measured for iron and manganese levels once every month for a period of six months from November 2003- April 2004 the results of the minimum, maximum, mean and standard deviations of the values are shown in table 4.1.

Table 4.1: Results of Swashi Well Waters Analysis

	UPS1		UPS2		DWS1		DWS2	
PERIOD OF ANALYSIS	Fe	Mn	Fe	Mn	Fe	Mn	Fe	Mn
minimum	0.97	0	0.6	0.56	0	0.1	0.87	
max	1.54	0.86	1.02	0.9	0.2	0.4	1.7	
mean	1.20	0.51	0.83	0.70	0.11	0.20	1.35	
standard deviation	0.20	0.32	0.17	0.15	0.09	0.11	0.30	

ups1 = upstream sample at point 1, ups2= upstream sample at point2, dws1 = downstream sample1, dws2= downstream sample at point2.

Mean Fe concentration = 0.87mg/L

Mean Mn concentration = 0.418mg/L

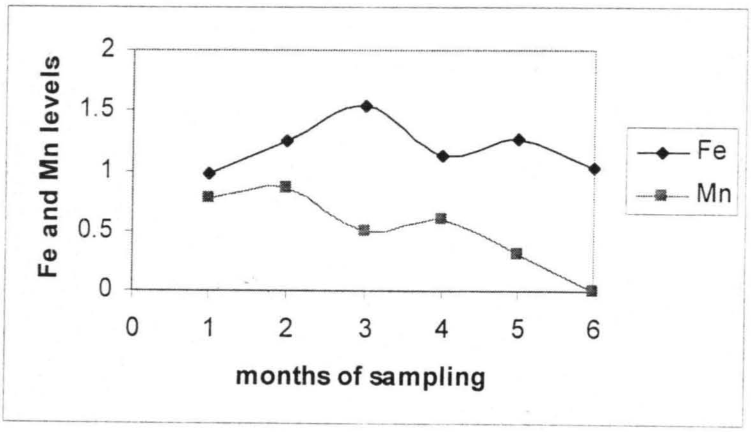

Fig. 4.1 Variations of Iron and Manganese levels in Upstream sample 1(UPS1)

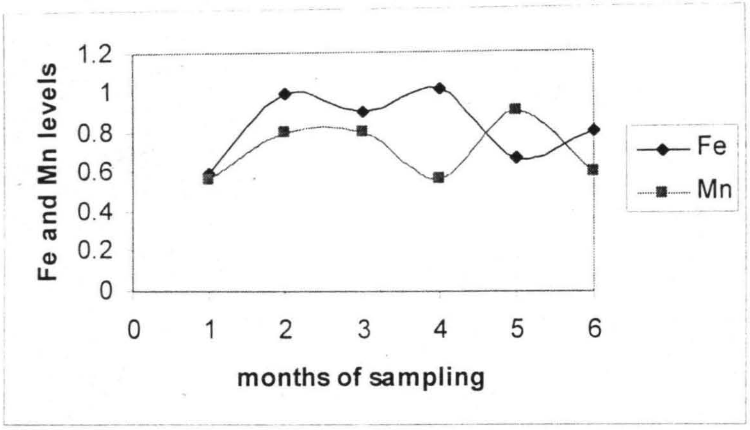

Fig. 4.2 Variations of Iron and Manganese levels in Upstream sample 2(UPS2)

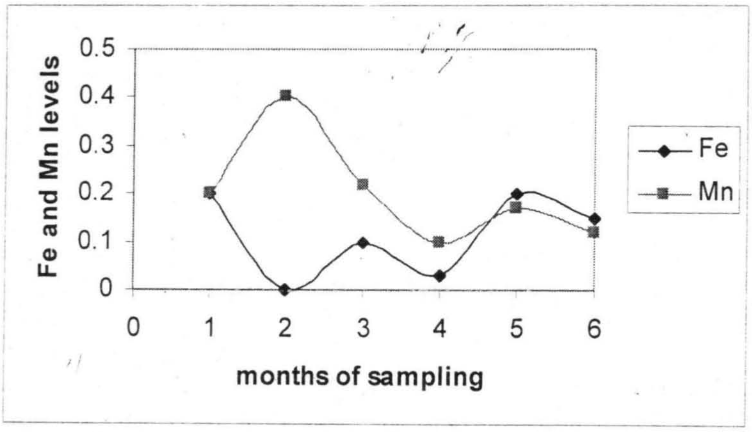

Fig. 4.3 Variations of Iron and Manganese levels in Downstream sample1(UPS1)

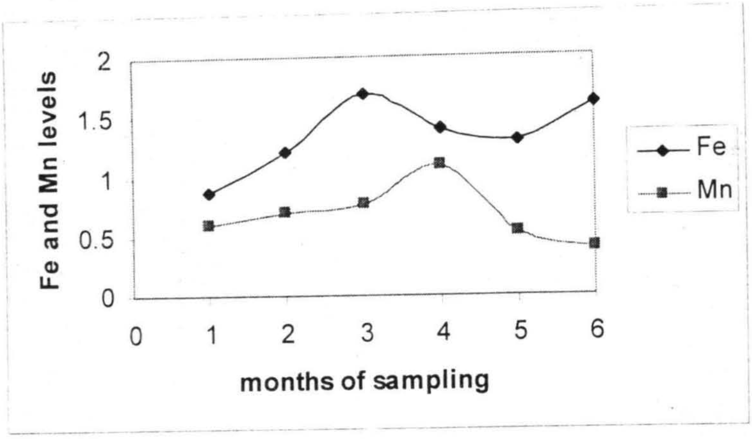

Fig.4.2 Variations of Iron and Manganese levels in Downstream sample2(DWS2)

These results indicate that the levels of iron far exceeded the WHO maximum permissible level of 0.3mg/L on several occasion in all the sampling points both at upstream and downstream area reaching a maximum level of 1.97mg/L in UPS1 which made the water non-potable. This result also shows that the irrigation activities does not have a significant effect on the rise in concentration of iron, however there seems to be increase in the concentration levels during the rainy season probably as a result of dilution and transport of the iron during this period. One can infer that the geological deposit of iron within the area may be responsible for the high iron concentration in Swashi irrigation area wells (Schwab,1990)

Manganese levels were also very high in all the wells as they exceeded 0.05mg/L which could affect the taste and odour properties of the water (Paul, 2002). The concentration of manganese exceeded this limit in most of the time particularly during the dry period. The irrigation activity does not seem to affect the level of manganese in the well waters as upstream and downstream wells of the sampling points do not show any significant difference in their values

CHAPTER FIVE

5.0 CONCLUSION AND RECOMENDATIONS

5.1 CONCLUSION

An assessment of Swashi Irrigation area wells was carried out for a period of six months, the variation in Iron and Manganese levels were looked into. The level of iron far exceed the WHO Secondary Drinking Water standard in all the wells, with three of the wells (Tungan Dari, Kwalla, and Tungan Alhaji) exceeding the maximum allowable level throughout the period. The level of manganese exceeded the limits in which the taste and odour properties of the water are affected. This makes the well waters non potable, and stains laundry for the inhabitant of the farming community. The removal of these undesirable elements by aeration or ion exchange will make the water potable and suitable for domestic use. This will have the potential of increasing the productivity of the people and by extension the capacity utilization of the irrigation project.

5.2 RECOMMENDATIONS

Iron and Manganese removal equipment can be installed for the people of the community. A simple aeration chamber can be mobilized for the people immediately. A more permanent solution to these community surrounding the irrigation scheme will be the construction of a water treatment facility to utilize the surface water from the dam that is in abundant

REFERENCES

Bruce S., Russel D., Fred B., (1992): Treatment systems for household water supplies: Iron and Manganese Removal. North Dakota State University Extension Service. AE-1030, North Dakota USA.

Machmeier, R.E. (1990): Iron in Drinking Water, AG-FO 1318. Minnesota Extension Service, University of Minnesota, Agriculture Faculty.

Nikoladze, D.G., (1989): Water treatment for public and industrial supply, MIR publishers, Moscow.

O'Connor, J.T. (1971): Iron and manganese. In M.E. Flentje and R.J. Faust (ed) pp380-396, Water Quality and Treatment a handbook of public water supplies, 3rd Edition. Prepared by the American Water Works Association, Inc. McGraw-Hill Book Co. New York, USA.

Paul, W. (2002): biological iron and manganese removal as a viable alternative for groundwater treatment. Journal of Environmental Science and Engineering http://www.esemag.com/index.html

Schwab .O.G., Fangmeier, D.D., Elliot, W.J., Frevert, R.K. (1992): Soil and Water Conservation Engineering, John Wiley and Sons, Inc New York, USA.

APPENDIX A

SAMPLE QUESTIONNAIRE

Federal University of Technology, Minna.

Department of Agricultural Engineering

This Questionnaire is design to seek information from you on designing a mini water treatment plant for Izom community.

RESPONDENT INFORMATION

Age…………………

Sex…………………

Area of Resident in Town …………………………………………………

Number in the Household…………..

Quantity of water used per person per day……………………………………….

Source of water, river…………well………borehole……………

Colour of water, clear………fair…………muddy…………

Taste of water, tasteless…………fair………………tasty………

What distance do you cover to get water……………………..

Which of these diseases have struck a member of the family before,

Cholera……….diarrhea…………scabies…………………guinea worm……….