TEST ANALYSIS ON EFFECTIVENESS OF CHLORINE DOSAGE ALONG GWAGWALADA WATER WORKS DISTRIBUTION LINE

BY

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DEDICATION

This project is dedicated to my success and parents.

CERTIFICATION

This project work (report) "Test Analysis on Effectiveness of Chlorine dosage" along Gwagwalada Water works distribution line F.C.T Abuja
Was conducted by myself Sanusi Adamu Jemaku (PGD/AGRIC. ENG/2000/2001/115) is submitted in partial fulfillment of the requirement for the award of Post-Graduate Diploma (D.G.D) in Agricultural Engineering (Soil & Water) of Federal University of Technology, Minna.

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ABSTRACT

This project work presents the treatment of raw water to portable drinking water. It involves various water treatments of chlorine with some chemicals found in water, various types of chemicals that are used in water treatment processes. Since the reason of treating raw water is for it be free from disease infection, this project aimed at testing the effectiveness of chlorine dosage along Gwagwalada water works distribution line. Water samples from the source (Usuma Dam) at different location to Gwawalada township are taken and tested for chlorine residual and where a break point of chlorinenation occurs bacteriology tests are also taken to ascertain the safety for human consumption. Along the distribution line, sample points taken for laboratory analysis at Usuma Dam Kuba Airport C.K.C Gwako and Kutunku at the Gwagwalada township extreme end. A table is also provided for some specified chemicals used for special purpose in the process of treating water.

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CHAPTER ONE

1.0 INTRODUCTION

1.1 Gwagwalada before the creation of F.C.T:

Gwagwalada town was formally part of Niger State of Nigeria but now one of the satelite towns of Federal Capital Territory (FCT). Before F.C.T was created, the town was under Niger State Government that takes care of the people's well being of this area. It is now an area council of the F.C.T and administered by MFCT (Ministry of Federal Capital territory).

1.2 Sources of Water Supply:

The main source of water supply to Gwagwalada was formerly from River Usuma but now from lower Usuma Dam, about 55km from Gwagwalada.

1.3 Population and Tribes:

From a population of less than 10,000 people before the creation of FCT, the town now has a population of over 104,000 people with numerous kinds of Nigeria tribes. Before F.C.T., major tribes found were Gwaris, Bassa and Koro being the native of the area.

1.4 Objective of Study:

The objective of this project work is to determine the effectiveness of chlorine dosage along Gwagwalada water works distribution lines.

1.5 Justification:

The quality of portable water should meet the World Health Organisation Standard (WHO). In Gwagwalada, these standards are most times not met. The dosing of chlorine to water becomes so necessary due to water pollution with uncountable number of pathogens which if chlorine is not found in such water, this may result in the spread of so many types of diseases.

1.6 Limitation

A manual measurement system was adopted. However an automatic system would have given a better result.

CHAPTER TWO

2.0 LITERATURE REVIEW

2.1 DESCRIPTION OF THE PROJECT AREA

Attached herewith is a map of FCT showing the pipe line distribution from lower Usuma Dam that supplies water to Gwagwalada town at present. Unlike before water from the adjacent river used to be treated which was in sufficient to meet the need of the daily growing population of the area. Water is now directly purpose from the above mentioned Dam through a pipe line network Airport to Giri and to Gwagwalada town from consumption. Such portability from far distant place brought about great concern in daily checking the condition of water quality, disinfection that may lead to dangerous water born disease and this is carried out through different type of treatment processes before the final treated water reach the consumer.

2.2 **Water Treatment:**

This is a process whereby natural occurring (raw) water, from a variety of sources is put through a series of steps designed to purify for the sole purpose of making it portable for human consumption.

The extents of treatment required usually depend on the nature (characteristics) of the raw water and the treatment quality desired. There are various water quality standards requirement to meet for human consumption and of the most referred to the world Health organization (WHO) for drinking water.

2.3 Why Treat Water?

For various reason and considering the variability of water quality there is the need to treat water usually for human consumption Natural waters, either surface or ground water may contain naturally occurring micro – organisms and chemicals which if consumed may be harmful to human life.

In addition human activities do quite often pollute bodies of water and thereby render such unfit consumption unless after treatment. In the operation of water treatment plants three basic objectives are permanent.

(i) Production of safe (portable) drinking water.

(ii) Production of aesthetically pleasing drinking water and

(iii) Production of drinking water at a reasonable cost with respect to capital and also operation and maintenance costs.

From the public health perspective, production is safe drinking water, one that is free of harmful bacteria and toxic materials, is the first priority. But it is also important to produce high quality water, which appeal to the consumer. Generally this means that the water must be clear (free of turbidity), colorless, and free of objectionable tastes and odors. Consumer also show a preference for water suppliers that are non-staining (plumbing Fixtures and washing clothes) non corrosive to plumbing fixtures and piping, and one of that does not leave scale deposit or spot glassware.

Consumer sensitivity to the environment (air quality, noise) has significantly increased in recent years. With regard to water quality, consumer demands have never beer greater. In some instance, consumers have subtitled bottled water to meet specific needs namely, for drinking water and cooking purposes Design engineers select water treatment process on the basis of the type of water source, source water quality and desired finished water quality established by drinking water regulations and consumer tastes.

Depending on the typical water treatment processes and plants, also on the sources and quality of the raw water.

2.4 Purpose of Treating Water:

The purpose of a water treatment plant is to produce safe and pleasant drinking water. The water must be free of disease causing organisms toxic substance and suspended particles. Also, the water should not have a disagreeable taste odour or colour.

2.5 Treatment Principles:

The raw water undergoes the following treatments so that the distributed water will be in conformity with the necessary standards.

These are:
- Aeration
- Prechlorination
- Coagulation – flocculation
- Settling
- Sand filtration
- **Determination of equitibrium p^H**
- **Disinfecton**

2.6 Aeration:

This consist of bringing water and air into close contact designed to:

- remove certain odours
- oxidize iron and manganese salts
- increase the oxygen content

2.7 **Prechlorination:**

Prechlorination ensures better filterability by helping coagulation, and permits a better water quality to be obtained.

Prechlorination is intended to:

- Destroy the existing micro – organization (algae, bacteria, plankton) likely to grow in the structures and the sludge blanket. It thus keeps the clarifies and fillers clean and prevents sludge within these clarifies.

- Oxidize the organic substance, which may form organosoluble complexes.
- Oxidize the nitrites to nitrates.

- Oxidize the ammonia

- Lower the taste threshold and often ensure better colour removal from the water.

A small amount of fees chlorine must remain in the raw water to ensure that prechlorination is active.

If the water has a break point, the amount injection must permit 0.2 – 0.3 mg/*l* free Chlorine to be obtained.

Chlorine is in injectal as:

- Chlorinated water from chlorine gas.

2.8 Coagulation – Flocculation:

Water contains very colloidal or pseudocolloidal suspended solids, which must be gathered into a bulky and heavy floc to allow settling to ensure flotation and help retention in the filters.

The interfaces of colloids are electrically charged, which prevent shear by particles from coming close together.

The action takes place in two steps:

- Coagulation; which destabilizes the colloids to give rise to a precipitate.

- Flocculation, which is intended to increase the volume and cohesion of the formed by coagulation. It is further improved by the addition of chemical used as flocculation aid, such as synthetic flocculent polyeletrolytes.

  Settling:- is designed to allow the particles in suspension in the water to settle, under the effect of gravity to improve water quality. These particles exist in the raw water and are precipitated into large (and thus heavier) flocculates by adding chemicals agent during flocculation.

2.9 Sand Filtration:

Filtration is designed to remove particles suspended in water, whether these particles exist in the raw water or result from a previous coagulation process.

The trapped suspended solids gradually block the interstices between the constituent – elements of the filtering media. This phenomenon is known as "filter clogging".

The rate of glogging depends on:

- The characteristics of the water, the more turbid the water, the faster the filter becomes clogged,
- The flow per unit of filtering area or filtration rate the head loss increases with the rate.

- **The grain size of the filtering media:** The finer the particles size of the filtering materials the more quickly it becomes clogged.

2.1.0 **Disinfection**

Definition:- Refers to the process of killing or in activation of pathogenic organisms as opposed to sterilization which means killing all living organisms.

2.1.0.1 **Purpose of Disinfection: -**

1. To kill pathogen in the water – Germicidal

2. To prevent any recontamination of the distribution system – Residual.

2.1.0.2 **General Properties of Good Disinfectant:**

(i) must destroy the kinds and number of pathogen that may be introduced into a water supply and distribution system within a practicable time, over an expected range of water temperatures

(ii) Must not be toxic to man and his domestic animals.

(iii) Should be easy to store, transport and handle

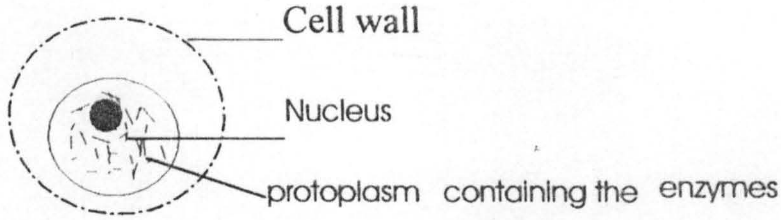
(iv) Must maintain residual effects, which would serve as an indication of no pollution condition sometimes later.

2.1.0.3 **How Disinfection take place:**

A disinfectant reacts with enzymes that are essential to the metabolic processes of cells and inactivates them. Basically this process takes place in two steps:

(i) The disinfectant penetrates the cell wall.

(ii) The disinfectant reacts with enzymes thus rendering the cell in active



Method of Disinfection:

Chlorination usually perform, as the final treatment process is the most common means of disinfecting drinking water. However other method are available and may be useful to some situations.

(1) Heat treatment

(2) Radiation

(3) Chemical treatment - Bromine (Br_2)

- Iodine (I_2)
- Ozone (O_3)
- Chlorine and (Cl_2)
- Chlorine compounds.

2.1.1 **CHLORINATION:**

Chlorination is the addition of chlorine to water and is the most common form of disinfection.

Consider the reaction of chlorine in distilled water fig. 1 the amount of FREE CLORINE RESIDUAL is directly related to the close or amount of chlorine added. The reaction occurs as follows.

Cl_2 + H_2O ⟶ HOCl + HCL ——— [1]

Chlorine   Water   Hydrochlorous acid   Hydropochloric acid

The product dissociate easily:

HOCL ⟶ H+ + Ocl ——— [2]

HCL ⟶ H+ + CL ——— [3]

Hydrogen ion   chlorine ion

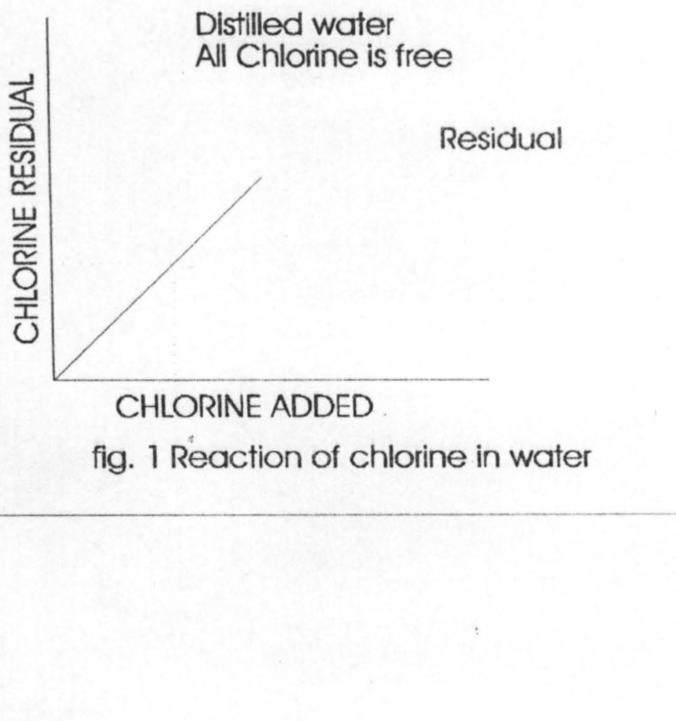


fig. 1 Reaction of chlorine in water

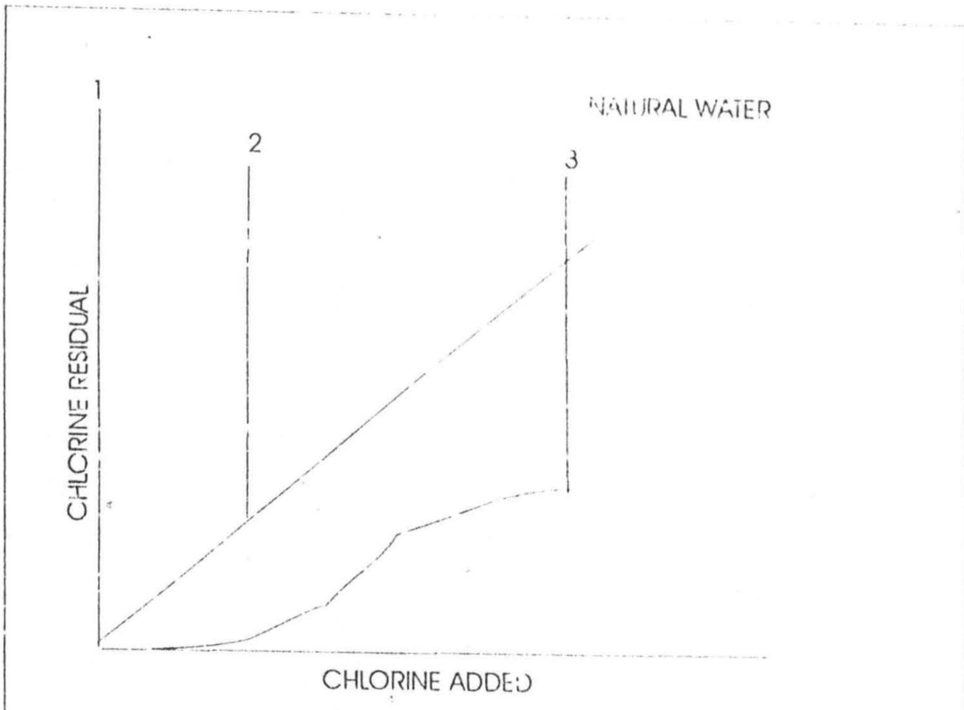


fig 2 REACTION OF CHORINE WITH IMPURITIES WATER

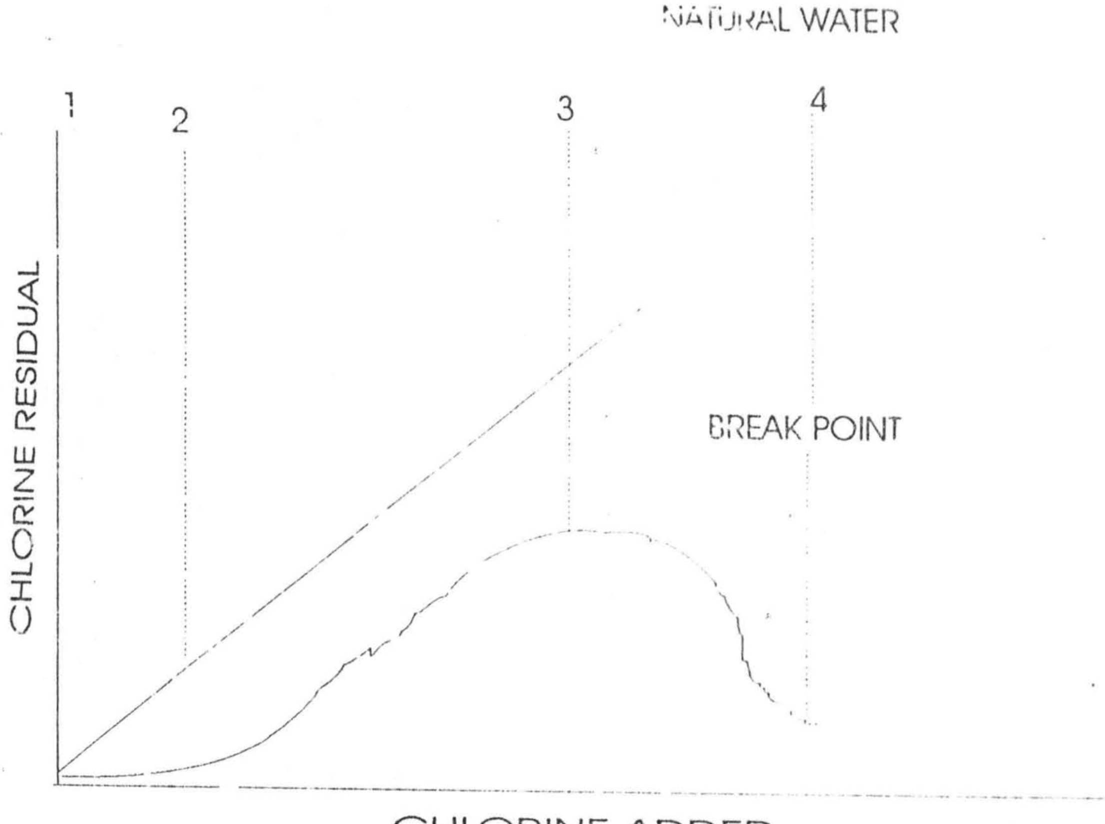


fig 3 DECREASE OF CHLORINF RESIDUAL

Hyperchlorous acid, one of the forms of free chlorine residual, is the most effective disinfectant available. When it dissociates as in equation 2, the hypochorite ion (the 2nd form of free chlorine) is formed which as a disinfectant is only 1/100 as effective as hypochlorous acid.

Natural water is not pure, and the reaction and the reaction of chlorine with the impurity it contains interfere with the formation of a free chlorine residual. For example, if the water contain organic matter, nitrates, iron Manganese, and Ammonia, then the chlorine added combines immediately with iron, Manganese, Nitrates which are reducing agents (No residuals). As more chlorine is added (see fig. 2) between point 2 and 3, it begins to react choro – organic compounds which are combined chlorine residual, but not as effective as a free chlorine residual.

Between point 2 and 3 the combined residual is primarily monochloramine.

$$NH_3 + HOCl \longrightarrow HN_2cl + H_2O \quad \text{———[4]}$$

Ammonia Hypochlorous acid Monocloramine Water

Adding more chlorine to the water (see fig 3) actually decrease the residual. The decrease (point 3 and 4) result because the addition chlorine also charge some of the monochloramine to diclorar and trichlora-mines.

$$NH_2CL + HOCL \longrightarrow NHCl_2 + H_2O \quad \text{———[5]}$$

Monochloramine Hypochlorus acid Dichloramine water.

As additional chlorine is added the amount of chloramine reaches minimum value. Beyond this point, further addition of chlorine products free residual chlorine. The point at which this occurs is known as the BREAKPOINT, (refer to fig. 3). To the right of the breakpoint, an increase in the chlorine dose will usually produce a proportionate increase in the free chlorine residual.

2.1.1.1 **Reaction of Chlorine with Chemicals found in Water:**

A large number of chemicals may be present in water especially wastewater or effluent from sewage treatment when it is chlorinated. These include nitrogenous compounds (especially ammonia), carbonecovis compounds, nitrate, iron, manganese, hydrogen sulphide and cyanides chlorine combines with these compounds in the following manner.

(a) **Nitrogen Containing Compounds:**

The compounds formed by the reaction of chlorine and a nitrogen containing compounds are chloramines, which could be either inorganic or organic.

(i) **Ammonia:-** This is the most important inorganic compound, which reacts with chlorine; others are nitrate and nitrites. Chlorine read in dilute aqueous solution (1-50ppm) to form three cholamines:

$$Cl_2 + NH_3 \longrightarrow NH_2CL + Hcl$$

Monochloramine

$$NH_2 + Cl_2 \longrightarrow NHCL_2 + HCL$$

Dichloramine

$$NH_2 + CL_2 \longrightarrow NCL_3 + HCL$$

Trichloramine

(Nitrogen trichloride)

These chloramines, also known as combined residuals are far less effective than chlorine as disinfectant agents, required about 10 times of chlorine. Further more they confer odour and taste to water.

The p^H of the water determines the relative amounts of the three kinds of chloramines. At pH 8.5 Monochloramine is the major product. If it is low e.g. below pH 4.4 virtually at the chlorimine is in the form of nitrogen trichloride (NCL_3) which imports a bad taste to drinking water and causes eye irritation in a swimming pools. At the same time it hardly disinfects.

(ii) **Organic Nitrogen:-** Organic nitrogen compounds include proteins and its various breakdown products i.e. proteases, peptones, poly peptides and amino – acids. These proteins which are of animals and plants origin regard chlorine with which they may react over several days known as chloro-organic compounds, they contribute to the odour of water furthermore they produce a series of Unstable residuals chloro-

organic compounds which titrate as combined chlorine are also believe no germicidal action apart from all these, organic nitrogen is undesirable because it is a fierily good indication of recent pollution. It has therefore been suggested that its amount in raw be limited to 0.3.mg/l. The smaller the amount of protein, the more available chlorine is for disinfecting.

(b) **Hydrogen Sulphide:**

H_2S is frequent dissolve under ground water and is common in waters where aerobic decomposition has occurred. At a P^H value of 6.4 and below the H_2S is completely oxidize given rise to sulfuric acid and hydrochloric acid.

$$H_2S + Cl_2 + 4H_20 \longrightarrow H_2SO4 + 8HCl$$

At higher values the reaction is thus: -

$$H_2S + Cl_2 \longrightarrow S + H_2O$$

(c) **Iron:**

The precipitation resulting from the reaction of chlorine and iron (i.e. Fe. $(OH)_2$) in water serves two useful purpose. First it helps remove iron, and secondly it helps produce a coagulant for treatment of the water. The ultimate reaction is thus:

$$2FeCL_3 + 3CA(HCO_3)_2 \longrightarrow 2Fe(OH)_3 + 6\ Co_2 + 3\ Cacl_2$$

(d) **Cyanide:**

The destruction of Cyanide by chlorine is most effective at high P^{H} values (8.5 - 9.5) when can be created when necessary by the addition of NaOH. Sodium Cyanate is produced which decomposes, releasing nitrogen.

$$2\ Cl_2 + 4\ NaOH + 2\ NaCN \longrightarrow 2\ NaCNO + 4\ Nacl + H_2O$$

(Cyanide Cyanate)

The complete reaction is thus:

$$5cl_2 + 10NaOH + NaCN \longrightarrow 2\ NaHCO_3 + 10Nacl + N2 + 4H_20\uparrow$$

(e) **Manganese:**

Chlorine reacts with Manganese at P^{H} 7 – 10,

thus:

$$MnSO_4 + Cl_2 + 4\ NaOH \longrightarrow MNo_2 + 2Nacl + Na\ SO_4 + 2H_2O$$

(f) **Methane:**

Methane is produce by anaerobic bacteria. Besides its unpleasant odour methane could be explosive. It is best remove by aeration, but chlorine also react with it.

$$2CH_4 + Cl_2 + H_2O \longrightarrow 4Hcl + H_2O$$

2.1.2 P^H

The P^H of water include the int sity of its acidic or basic intensity. The P^H scale runs from 0 – 14. Wate aving a P^H of 7 is the midpoint of the scale and is considered neutral. T storage the basic intensity the greater the P^H. The opposite is true of the acidity. The storage the intensity of the acidity, the lower will be the P^H

P^H Scale

← Increase Acid ——— 7 ——— Increasing Base ——→ 14

1-2-3-4-5-6- neutral 8-9-10-11-12-13-

Mathematically, P^H is the logarithm of the reciprocal of the hydrogen iron activity, or the negative logarithm of the hydrogen iron activity

$$P^H = \log 1/(H^+) = \log (H^+)$$

For Example;

If water has a pH of then the hydrogen ion activity $(H^+) = 10^{-1} = 0.1$

If any P^H is then is 7, then $(H^+) = 10^{-7} = 0.0000001$

A change in the P^H of one unit is caused by changing in the hydrogen ion level by a factor of 10 (ten times).

In a solution, both hydrogen ions (H+) and the hydrogen ions (OH-) are always present.

At P^H of the activities of both hydrogen and hydroxyls ions equals 10-7 moles per liters. When the P^H is less then 7, the activities of hydrogen ions is greater than the hydroxyl ions.

The P^H of water has a very important influence on the effectiveness of chlorine disaffection chlorine is a chemical reaction in which chlorine is oxidizing agent. Chlorine is a more effective oxidant at lower P^H values. Simply stated, chlorine residual of 0.2mg/l at a P^H of 7 is just as effective a 1mg/l at P^H of 10. Therefore five times as much chlorine is required to the same disinfecting job at PH10 as it does at P^H 7.

2.1.3 CHEMICAL TYPE AND THEIR CHARACTERISTICS

Chemical Name:	Chemical Formular	Available forms	Appearance

A. **Coagulant:**

Auminiumsulphate $AL_2 (So_4)_3$ 14 H_20 Granular ligth to grey

(Alum) Powder green dusty.

Ferric sulfate $fe_2 (S0_4)_3$ $9H_20$ Acidic

Shining

B. **Disinfection**

Sodium Hypoch - Naocl solution

Calcium Hydpo – $Ca(ocl)_2$ - $ H_2O Powder, White or Yellowish

Granules, White.

Chlorine Cl_2 Gas/Liquid Greenish yellowish,

Pungent, noxious

C. **Taste and Odour**

Activated Carbon C Insolible

Potassium Permanganate – $Kmno_4$ very soluble.

D. **Algea Control**

Copper Sulphate $CuS0_4$ $5H_20$

E. **Correction Control**

Sodium Hydroxide

(Caustic soda) NaOH Very Basic

F. **Softening**

Calcium oxide Cao lumps, pebbles white, caustic,

Irritation

Unstable

Sodium Carbonate $NaCo_3$

(Soda Ash)

G. **Fluoridation**

Sodium Floride Naf Powder or Crystal

Fluosilicic Acid H_2SiF_6 Solution

2.1.4 Chlorine Demand Test Analysis

Since the topic is concerning effectiveness of chlorine dosage along Gwagwalada water works distribution line, first it is important to know the amount of chlorine as disinfectant to be closed at the treatment plant water source (Usuma Dam), and such dosage is determined by a test known as "chlorine demand" necessary for disinfectant so as to obtained a chlorine residual of 0.1 – 0.3 mg/l required by WHO – IRC, TP 11 of 1978.

However this plant of Usuma Dam is designed and operated in a way the use of crystal powder chlorine and gaseous are possible, depending on the one available and circumstance warranting at a particular time.

Chlorine demand test using powder is carried in the following ways:

Procedure:

Determination of the chlorine demand of water for disinfection:

Scope:

Laboratory determination of the treatment dosage to be applied to the raw water in order to achieve necessary results.

Apparatus:

- Six 1 – liter bottle with stoppers
- 1 10ml pipette graduated in tenth of milliliters
- One 25 pipette graduated in tenths of milliliter
- One 1,000ml cylinder
- Two 200ml flasks with stoppers

Stock solution: (20g/l of chlorine)

- Weight 6.5 of calcium hypochlorite and pour into a 250ml cylinder.
- Pour in distilled water up to 200 mark
- Close the cylinder with the palm of the hand scale with care for fire minutes
- Let it settle unit the liquid is limpid and the insoluble impurities have settled to the bottom of the cylinder.
- Transfer the supernatant liquid into a dark bottle which must be carefully stoppered

A 1g/l solution must be prepared for the determination of the "chorine demand".

Chlorine solution (1g/l):

- Transfer 10ml of stock solution already prepared into a 250-ml cylinder.
- Add distilled water up to the 250 mark

- Close the cylinder with the palm of the hand and shake with care by turning the cylinder upside down several times for 4 –5 minutes so as to mix well.

Dosage: The dosage is according to pipelted volume for one liter of water to be treated.

Chlorine damage = Amount added – Residual.

Result:

Jar No. (1000 ml)	Pipetted Vol. (cm^3)	Dosage g/l3	Residual mg/l
1.	0.5	0.5	0.0
2.	1.0	1.0	0.1
3.	1.5	1.5	0.3
4.	2.0	2.0	0.4
5.	2.5	2.5	0.6
6.	3.0	3.0	0.6

The Residual is obtained by apply the 0 – Tolidine method.

Calculation:

Pump flow rate = $5000m^3/hr$

Dosage chosen = $1.5g/m^3$

Chlorine demand = flow rate X Dosage

$= 5000m^3/hr \times 1.5g/m^3$

$= 7500m^3/hr$

$= \underline{7.5\ kg/hr}$

Therefore at the chosen dosage of $1.5g/m^3$ it will require 7.5kg/hr of chlorine when the residual was found to be 0.3 mg/l at the treatment plant but at other points along the line at Gwako C.K.C being very far away from the station, from research so far condition no residual at those points. With other discovery further test on mocro – organisms that may otherwise be dangerous to him to human has to be conducted.

Chlorine Demand Test in Gaseous Form:

Here, the chlorine is in cylinder in gaseous form with net weight 100kg, which is released by the use of "injectors".

The injection dose chlorine gas into a solution of water before passing into the raw water. The injection was set to mix chlorine into at the following rates.

5kg/hr ——————————► $9m^3/hr$

5000g/hr ——————————► 9000l

In other to obtain 1g/l;

5000g ——————————► 9000l

1g ——————————► xL

$\therefore$ X liters $= 1g \times \frac{9000L}{5000g} = \frac{9}{5} L$

$\therefore$ 1g/L = 1.8L of chlorine water was prepared of the 5kg / $9m^3$ stock solution.

CHAPTER THREE

3.0 METHODOLOGY

3.1 Test Analysis of Chlorine is carried out by using Orthotolidine (0 – tolidine), a redox indicator.

3.1.1 Method: (Hydrocure Colourimetric Method).

This method of testing the presence of chlorine in water, which becomes yellow using 0 – tolidine, a redox indicator is carried out in the following procedure:

A.1 Principle

O-tolidine – a redox indicator, becomes yellow in the presence of chlorine in acid medium. The yellow colour of this complex is increasingly deep with the chlorine concentration.

3.1.2

A.2 Apparatus:

- One hydrocure calorimetric comparator,
- Two graduated cells: A&b,
- One reference plate: chlorine 0.1 to 2mg/l

3.1.3

A.3 Regent:

O-tohidine, 0.1% in volume in 10% reagant grade hydrochloric acid solution.

3.1.4

A.4 Procedure:

- Rinse the two cells with sample water and shake them dry,
- Fill one of the cells up to mark B with sample water and place it on the side opposite to the reagents mark in the comparator,
- Fill the other cell with sample water add to drop O tolidine mix and place on the side marked regents,
- Immediately introduce the chlorine 0.1 to 2mg/l reference plate into the compartment placed under the front of the cooperator and immediately proceed with
- reading by sliding the reference plate until appears the coloured screen which has the same colour as the sample plus the o-tolidine,
- The reading is that of free chlorine content
- Wait 10 minutes and proceed with another reading as previously,
- The reading is that of the total chlorine content,
- If the colour of the water sample falls between two reference screens take the average reading of the screens

As far as this project work is concerned samples of water at interval distances between the Gwagwalada source of portable water (Usuma Dam) will be taken and tested to determine the effectiveness of chlorine residual at each point to Gwagwalada town.

Samples were taken the Dam site, Kuba, Airport, Gwako, C.K.C and Kutunku inside Gwagwalada town where pipeline touched.

3.2.0 **Bacteriology Test Analysis:**

3.2.1 The Coliform: All organism that produce a red colony with a metalic sheen within 24 hrs incubation at 25^0C on an Endo – type medium are considered members of the coliform group. The sheen may cover the entire colony or may appear only in a central area or on the periphery. The coliform group thus defined is based on the production of alge Hydes from fermentation of lactose. While this biochemical characteristic is part of the metabolic pathway of gas production in the multiple tube tests some variation in metabolic sheen development may be observed among coliform strains. However this slight difference in indicator definition is not considered to change its public health significance, particularly suitable studies have been conducted to establish the relationship between results obtained by this standard tube dilution procedure.

3.2.2 **Materials and Method:**

For the purpose of this research the membrane filtration technique was employed. Generally, there are other methods of bacteriology assessment of water, and these are:

1. Must probable number method (M.P.N.)

2. The power plate method (P.P.M)

3.2.3 The Materials Used in the Membrane Filtration Method are:

1. 100ml water samples.
2. Membrane filtration chamber
3. Electric pump
4. Membrane paper (47mm Dai, 0.45 min pore size)
5. Filler pad
6. Sterile forceps
7. Disposable petri dishes (50 x 12mm)
8. M. Endo medium & LES end.
9. Absorbent pads (48mm & absorbent capacity of 1.8 to 2.2ml)
10. Incubator
11. Oven

3.2.4 <u>Composition of medium:</u>

3.2.4.1 LES Endo agar:

Yeast Extract 1.2g

Casitive or trypticase 3.7g

Thiopeptone to thiotone 3.7

Trptose -- 7.5g

Lactose -- 9.4g

Dipotassium hydorogen phosphate

K2Hpo 4 -- 3.3g

Sodium chloride Nacl -- 3.7g

Sodium disoxycholate -- 0.1g

Sodium Lauryl sulfate --- 0.5g

Sodium sulfite Na2 SO3 -- 1.6g

Basic Fuchsin --- 0.8g

Agar -- 15.0g

Distilled water -- 1L

3.2.4.2 **M – Endo medium:**

Tryptose or polypeptone --10.0g

Thropeptone or thiotone -- 5.0g

Casitone or trypticase -- 5.0g

Yeast Extract -- 1.5g

Lactose -- 12.5g

Sodium chlorine Nacl --- 5.0g

Dipotassium hydrogen phosphate,

K_2HPO_4 -- 4.375g

Potassium hydrogen phosphate

KH_2PO_4 -- 1.375g

Sodium lauyl sulphate -- 0.050g

Sodium Desoxycholate -- 0.10g

Sodium Sulphate $Na2SO_3$ -- 2.10g

Basic fuchsin -- 1.05g

Agar --- 15.0g

Distilled water -- 1L

3.2.4.3 **Filtration of Sample:** Using strile forceps, place a sterile membrane filter (Grid side up over porous plate of receptacle.

Care place matched funnel unit over receptacle and locks it in place. Filter sample under partial Vacuum.

With filter still in place rinse funnel by filtering three 20 – 30 ml portion of sterile dilution water. Upon completion of final rinse and the filtration process disengage vacuum.

With filter still in place rinse, rinse funnel by filter three 20 – 30ml portion of sterile dilution water.

Upon completion of final rinse and the filtration process disengage vacuum unlock and remove funnel, immediately remove membrane filter with sterile forceps, and place it on selected medium with a rolling motion to avoid entrapment of air insert a sterile rinse water sample (100ml) after filtration of a series of 10 samples to check for possible cross contamination or contaminated rinse water.

Incubate the control membrane culture under the same condition as the sample.

Place a pad in the culture dish and saturate with 1.8 – 2.0ml M – Endo medium, place prepared filter directly on pad, invert dish, and incubate for 22 – 24 hrs at 35 ± 0.5^0C.

CHAPTER FOUR

4.0 Results and Calculation

4.1 1ST TEST

TOWN LOCATION ALONG PIPELINE FROM USMA DAM GWAGWALADA	CHLORINE RESIDUAL (mg/l)
Usuma Dam	0.8
Kuba	0.2
Airport	0.1
Gwako	-
C.K.C	-
Kutunku	-

Based on the test being carried out at different town location along the line chlorine residual within Usuma Dam is up to 0.8 mg/l Kuba 0.2 m/l, Airport 0.1 while the remaining locations to Gwako, C.K.C and Kuntunku were found to be with no chlorine residual at those points. However the absence of chlorine residuals at those locations does not mean that the water under consumption are not safe to humane. To ascertain the safeness for human consumption further tests on bacteriology has to be carried out at those places as the Dam site, Kuba and Airport satisfy the health organizations. Since the effectiveness of chlorine within those places range from 0.1 – 0.3 mg/l chlorine residuals.

4.1.1 2^{ND} TEST OF CHLORINE EFFECTIVENESS FROM USUMA DAM TO GWAGWALADA

TOWN LOCATION	CHLORINE RESIDUAL (MG/L)
Usuma Dam	0.9
Kuba	0.3
Airport	0.2
Gwako	-
C.K.C	-
Kutunku	-

RESULT:

The result for this test emerged with Usuma dam to be 0.9mg/l, Airport's 0.2mg/l of chlorine residuals while stations at Gwako C.K.C and Kutunku in Gwagwalada extreme ends in Gwagwalada found to be with no chlorine residuals.

Suggestion:

The absence of chlorine residuals within these points might result from too much distance from one station to another and volatility of chlorine itself. As such the erection of dosing station at interval will be very important which already moves towards that has been geared on.

4.1.2 3RD TEST OF CHLORINE EFFECTIVENESS FROM USUMA DAM TO GWAGWALADA

TOWN LOCATION	CHLORINE RESIDUAL (MG/L)
Usuma Dam	0.8
Kuba	0.3
Airport	0.1
Gwako	-
C.K.C	-
Kutunku	-

The result for this test are as follows. At Usuma Dam site the chlorine residuals was found to be 0.8mg/l, Kuba 0.3mg/l and Airport was found to be 0.1 mg/l of chlorine residual.

Station at Gwako, C.K.C and Kutunku were all found to be with no chlorine residual at those points.

When an observation is made on the three tests so far conducted, it will be seen that in the second and third test at Kuba, chlorine residuals were fund to be 0.3mg/l. And Airport 0.1 from there to Gwagwalada no residual at all.

4.1.3 AVERAGE OF THE THREE TESTS

Town location	First test (mg/l) (mg/l)	Second test (mg/l)	Third test	Average (mg/l)
Usuma Dam	0.8	0.9	0.8	0.83
Kuba	0.2	0.3	0.3	0.27
Airport	0.1	0.2	0.1	0.13
Gwako	-	-	-	-
C.K.C	-	-	-	-
Kutunku	-	-	-	-

Station at Gwako C.K.C and Kutunku from the table above, the result of the test show no chlorine residual at all. This necessitate the bacteriology examination to be carried at those points out respectively so as to ascertain weather the water reaching those areas are safe for human consumption.

4.1.4 CALCULATION

It is very important through the average of the three test carried out along the distribution line the standard deviation (S.D) or standard error (S.E) to be calculated. Standard deviation is given as

$$SD = \sqrt{\frac{\sum f(x-x)^2}{S.F}}$$

Where:

S.D = Standard Deviation

$\bar{X}$ = Mean of Numbers

X = The Number.

S.F = Sample Frequencies.

Going back to the table showing average of the test:

$$\bar{X} = \frac{0.83 + 0.27 + 0.13}{3} = 0.14$$

X = 0.83, 0.27, 0.13

S.F = 3

$$S.D = \sqrt{\frac{\Sigma f\,(x - x)\,2}{Sf}}$$

$$= \sqrt{\frac{1\,(0.83 - 0.41)^2 + (0.27 - 0.41)^2 + 1\,(0.13 - 0.14)^2}{3}}$$

$$= \sqrt{\frac{0.17 + 0.2 + 0.84}{3}} = \sqrt{\frac{0.28}{3}}$$

$$\sqrt{0.093} = 0.305$$

S.D = 0.31

Standard Error S.E = $\frac{SD}{\sqrt{n}} = \frac{0.31}{\sqrt{3}} = \frac{0.31}{1.73}$

Where n = 3

= 0.179

= 0.18

From statistical calculation of this test, it was found for standard deviation (S.D) and standard error to be 0.31 and 0.81 respectively.

To meet World Health Organization standard water to be safe for human consumption (S.H.H.C) residual chlorine should range from 0.1 to 0.03 mg/l with reference to this project sample points Gwako, C.K and Kutunku are found to be with no residuals chlorine although water tested were safe for human consumption at those places.

Already plans for building more dosing stations along the line at Airport and Giri are on the pipeline to overcome the fear for possible contamination. However continuously daily bacteriological tests are always being carried out for those points. And very soon the line will be rich with residual chlorine throughout for disinfection.

4.1.5 **Result on Chlorine Tests:**

The results of chlorine tests in the residual chlorine column shows that the first test carried the residual chlorine from Usuma Dam can only reach Airport i.e. 0.8mg/l at Usuma Dam, 0.2 at Kuba and at Airport 0.1mg/l. the rest of the sampling points Gwako, C.K.C and Kutunku are found to be with no residual chlorine at all. In the second test, residual also stops at Airport. Gwako, C.K.C and Kutunku who no residual. In the third test the same thing.

Average readings of the three tests were taken Standard Deviation and Errors were also calculated and found to be 0.31 and 0.18 respectively which is in line with the need of World Health Organisation Standard (WHO – IRC, T.P. II of 1978).

4.2.0 **Result and Calculation on Bacteriology**

The typical coliform colony has pink to dark – red colour with a metallic surface sheen. The sheen area may vary in size form a small pinhead to complete coverage of the colony surface. Count sheen colonies with the aid of low – power (10 tons magnifications) binocular wide field dissecting microscope or other optical device, with a cool white fluorescent light source directed from above, and as nearly perpendicular as possible to the plane of the filter.

Colonies that lack sheen may be pink, red, white or colorless and are considered to be non-coliforms. The total count of colonies (coliforms and non-coliforms) on Endo type medium has no relation to the total number of bacteria present in original sample.

4.2.1 **Lactose Fermentation:-** Verily all sheen colonies include the direct count or a medium of five such colonies from drinking water sample by transferring growth from colony to lauryl tryptose broth; include at 35 ± 0.5^{0}c for 48hrs.

Gas formidium lauryl tryptose within 48hrs verifies the colony as a coliform. For the research conducted at the following points Airport, Gwako, C.K.C and Kutunku respectively, the result below was obtained.

4.2.2 1ST TEST ON BACTERIOLOGY

Sample at points	Suspected Organisms	No. of colonies	Remarks.
Usuma Dam	Nil	Nil	S.F.H.C
Kuba	Nil	Nil	S.F.H.C
Airport Gwako	Entrobactor Aerogenes E.coli Other coliforms	2	Contaminated
C.K.C	Nil	Nil	S.F.H.C
Kutunku	Nil	Nil	S.F.H.C

S.F.H.C: Safe for Human Consumption.

4.2.3 Computation:

Total coliform colonies/100ml sample.

$$= \frac{\text{Coliform colonies counted x 100}}{\text{Total sample filtered}}$$

$$= \frac{5 \times 100}{100mL} = \text{5 colonies per 100 sample.}$$

From the result obtained on test, one can clearly see point at Gwako, the water there has been contaminated due to the presence of a number of pathogenic organisms hence not safe human consumption. Reason for water at this point was brought about due repairs going on loosed sluice value.

that was seriously leaking. All water flowing above this point after the repair got accomplished was disposed of through wash out valve so that clean water can be replaced.

4.2.4 2ND TEST ON BACTERIOLOGY

Sample at points	Suspected organisms	No. of colonies	Remarks
Usuma Dam	Nil	Nil	S.F.H.C
Kuba	Nil	Nil	S.F.H.C
Airport	Nil	Nil	S.F.H.C
Gwako	E.coli	1	Contaminated
C.K.C	Nil	Nil	Nil
Kutunku	Nil	Nil	Nil

In this test only one number of suspected organism of E.coli still water there happened to be considered unsafe for human consumption. Since it is one therefore there is need for computation.

4.2.5 3RD TEST ON BACTERIOLOGY

Sample at points	Suspected organisms	No. of colonies	Remarks
Usuma Dam	Nil	Nil	S.F.H.C
Kuba	Nil	Nil	S.F.H.C
Airport	Nil	Nil	S.F.H.C
Gwako	Nil	Nil	S.F.H.C
C.K.C	Nil	Nil	S.F.H.C
Kutunku	Nil	Nil	S.F.H.C

Under this test so far carried out there is never found any pathogenic organisnism found in water samples at any points of the locations along the line from Usuma Dam to Kutunku end point at Gwagwalada town that may otherwise render the water in safe for human consumption.

In summary out of the three tests carried out about bacteriology it is only first and second test pathogens were discovered in the water. At Gwako sampling point because of the damaged value there many pathogens were discovered with some members of colonies. The was immediately repaired and that's why in the second test only one E. Coli pathogenic was discovered and in the third test no any pathogen found.

Water then became safe for human consumption. No fear for water born disease in the process of consumption.

Conclusion

Based on the series of bacteriological test carried out along the line of distribution it concluded that water through out the line is safe for human consumption (S.F.H.C).

CHAPTER FIVE

5.0 Discussion, Recommendation and Conclusion

5.1 Discussion:

Based on the result obtained from different types of tests carried out, myself and some members of staff of the organisation held a discussion since the effect of chlorine residual only stopped at Airport sampling station. The rest of the stations i.e Gwako, C.K.C and Kutunku none is existence.

5.2 Recommendation:

Since some sampling stations tested were found to be with no chlorine residual effect, then it is recommended that more dosing station are to be constructed. If this is done especially at Airport and Giri along the line of supply, the rest stations chlorine will be more effective in order to overcome the fear of disease infection by consumers.

5.3 Conclusion:

The effectiveness of chlorine dosage was noticed from Usuman Dam to Airport. From airport to Gwagwalada town the dosage was not noticed. The Authority should urgently build the planned dosing station at interval so as to purify the water to be safe for human consumption. As water is life, F.C.T Water Board is always interested in protecting the safety of lives of its consumers.

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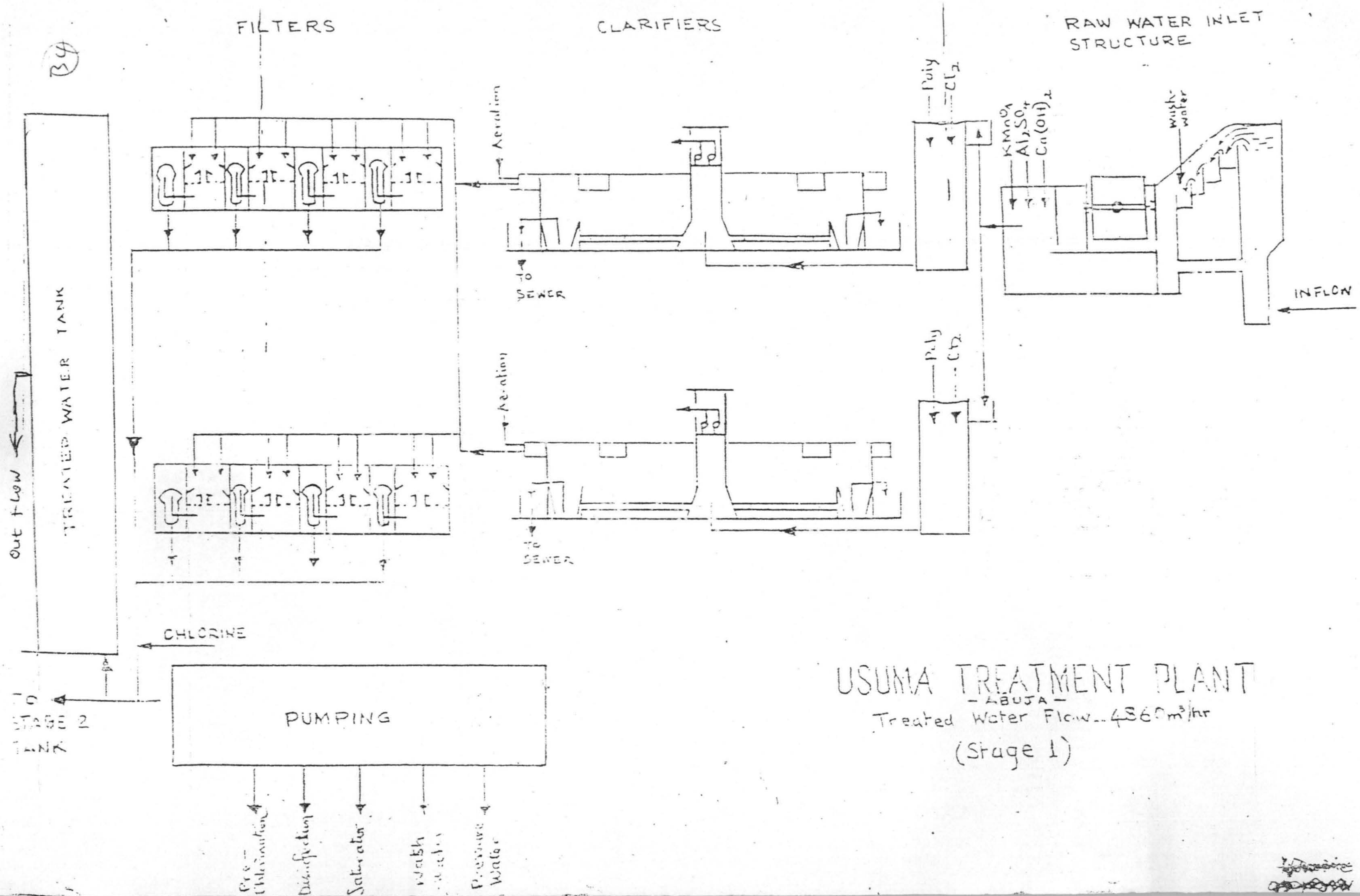

USUMA TREATMENT PLANT

- ABUJA -

Treated Water Flow .. 4860 m^3/hr

(Stage 1)