Title Page

EVALUATION OF ABUJA WATER SUPPLY

BY

NASIR ABDULLAHI ILLO
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BEING A THESIS SUBMITTED TO THE DEPARTMENT
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AUGUST, 2000

CERTIFICATION

This is to certify that, this project is original work of Nasir Abdullahi I110, carried out wholly by him under supervision and submitted to the department of Agricultural Engineering Federal University of Technology Minna.

....

Mr. S.O AYODEJI DATE

(PROJECT SUPERVISOR

....

Dr. (ENGR) M.G. YISA DATE

(HEAD OF DEPARTMENT)

DECLARATION

I HEREBY DECLARE THAT THIS RESERCH WORK HAS BEEN CARRIED OUT SOLELY BY ME UNDER THE GUIDANCE AND CONCTRUCTIVE CRITISM BY ENGR. AYODEJI O.S OF THE CIVIL ENGINEERING DEPARTMENT F.U.T. MINNA, AND I HAVE NEITHER COPIED SOMEONE'S WORK NOR SOMEONE DONE IT FOR ME.

WRITERS WHOSE WORK HAS BEEN REFERED TO IN THE PROJECT HAS BEEN DULY ACKNOWLEGED.

NASIR ABDULLAHI ILLO

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STUDENTS SIGN **DATE**
PGDAGRIC/98/99/65

AUGUST 2000

DEDICATION

I dedicated this Research work to my late Father Mal. Abdullahi Maiyaki Illo

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This Research work wouldn't be complete without acknowledging the contributions of individuals and organisations whose inputs in one way or the other has helped in the fufillment of this academic pursuit

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Nasir A. Illo
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ABSTRACT

The water supply in Abuja FCT metropolis has been Evaluated. The Evaluation was done through field measurement in terms of quality and quantity. The result obtained shows that a total of 240,000M^3/day of water is supplied to the territory in contrast to the demand of about 600,000M^3/day. The laboratory test conducted, however, indicate that the water quality is in compliance with W.H.O International standard. The water supply is inadequate, therefore there is need to increase the capacity of the treatment plant.

Table of Contents

LIST OF TABLE

CHAPTER ONE

1.1 INTRODUCTION

"Water", they say Sustain life. It existed on this planet long before life evolved and that all the complex chemical process involved in the development and maintenance of living organism are therefore sensitively attuned to the physical properties of liquid water. No wonder it is called the matrix of life.

The interplay of water and life can be considered at 3 different stage. At basis stage, the electronic structure of the water molecule is responsible for the physical properties of liquid most of which are quite atypical as judge by the casual chemical and physical standards. We can also consider water as one of the necessary molecular reactant of biological synthesis and metabolism. At yet more complex stage, water is the carrier which serves to distribute nutrients (food) and other essential chemical throughout the organism. Finally, water forms the natural habitat of many forms of life and is considered to be one of our most valuable resources that so much effort is now devoted to its management and yet it's all-important role in the maintenance of life is not generally appreciated or taken for granted.

The complex interaction between water and life process are therefore fundamental to our need for supplies of pure potable water.

Pure potable water is virtually vital for human survival and is essentially for many industrial process. Ironically, human industrial and agricultural process are making it increasufly difficult to get pure water as virtually any source except possible deep wells or mountain stream which are liable to chemically or biologically be polluted.

However, water is said to be pure when it is physically, chemically colourless, odourless, tasteless and bacteria - logically free from any micro organism that may be present in the water. Here, the quality of water depend on three main parameters physical, chemical and micro-organism, plants and animals.

No community can develop without adequate supplies of pure potable water. In fact, the growth of any community and their rapid civilization lies within the region of abundant water supplies. As the population increases, the demand would eventually increases.

In the ancient time, man doesn't have any idea of the quality of drinking water rather than its clearity and availability. As civilization advances they realized that pure water is essential item for good health and that impure water may caused infections which would eventually resulted in death of many people. As such they started filtering the water before drinking by any means, but the most important fact was that the degree of its clearity was not measurable from the knowledge of filteration and this lead to technological improvement of filters and treatment plant.

Towards the end of the Eighteen Century, they realizes that even after filteration, the water may still contain virus and bacteria which are harmful unless otherwise these water are treated chemically then it is safe. Also, the quantity of water counts in the development of a community the world over, lack of it attracts or dissuades settlement the world over. The problem that causes water shortage in continental or National basis is also true for small communities.

Thus cities may well experienced period of rapidly increasing demand which could result from industrial or domestic development but there can be no water shortage. The exploitation of the available resources will become more costly as future demand increases but we can obtain all the additional waters desired provided we are willing and able to pay the high cost.

1.2 JUSTIFICATION OF THE RESEARCH

Prior to the creation of Abuja as the federal capital territory of the Nigerian Nation in 1976 by the then Head of state late General Murtala mohammed when he set up the justice

Akinola Aguda committee to look in to the possibilities of changing Nigerian Capital from Lagos; Abuja was faced with problems of shortage of water supply, good road network and electricity supply among others.

However the creation and selection of Abuja as the new federal capital territory was based on the following important criteria:-Centrality, and climate, land availability and use, water supply, security, existence of local building Material, low population density, power resources, damage, soil and physical planing. Considering the above factors, Abuja city being in the middle Belt of Nigeria, just north of the confluence of river Niger and River Benue was selected and later renamed THE FEDERAL CAPITAL TERRITORY (F.C.T).

The report of the committee submitted however justified this: "We are fully conscious of the necessity for the existence at or quite close to the location for the capital of adequate water supply. In our view, this is most desirable, but what is, perhaps, of greater important is the possibility for 'Manufacturing' and delivering the required water of the right quality and in sufficient quantity for efficient functioning of the capital territory (meeting domestic, industrial and environmental needs). We are well aware of the fact that in some countries water is transported across long distances (say up to 180 kilometres as in New York) for use in the capitals.

"A location where there is an adequate natural water supply of the right quality or a location near such a place is most desirable. Here we have taken in to consideration not only surface water, but the possibility of underground water and adequate rainwater. Because of the importance we have attached to this factor, we have given it a rating of 100." (1)

The total scores for the creation of F.C.T. was 100 percent of water needs. From inception in 1976, water supply in the federal capital city (F.C.C.) was managed by a sub-directorate in the department of Engineering services of the Federal Capital Development Authority (F.C.D.A.) until the inauguration of the Federal Capital Water Board some Thirteen (13) years after, i.e in October, 1989.

Among others, the Board has the responsibilities of :-

- Providing healthy and adequate water for human consumption and industrial uses in the Federal Capital Territory entirely.
- To control, manage, install, maintain all water works and services vested or to be vested on the board by the Minister of Federal Capital Territory.
- To ensure the supply of potable water of adequate quantity and quality for the territory at an economic rate.
- To harness all water resources of the territory for

economic development .

- To encourage the conduct of research for the purpose of carrying out it's function.
- To submit the result of such research to the Minister for policy formulation relating to water supply and pollution control in the territory.

The lower Usuma Dam remains the primary source of water supply to the Capital city and it's environs. Constructed in 1984, the Dam has a reservoir of a maximum capacity of 100 million cubic meters and is equipped with water treatment plant having a designed capacity of $5000m^3$/hr, and has since, 1996 been running at full capacity but with increasing population growth, supply from this source has become inadequate.

To boost water supply in the long term, therefore government has awarded contract for the construction of additional water treatment plant at the Dam that will double water supply in the territory (i.e 10,000 cubic metres/hr).

The plant constructed by Messrs S.C.C. Nig. Ltd. Was completed within the scheduled 18 months and was commissioned on 25th May, 2000.

The question here is, can this efforts solve the water problem in the city? Because according to the Director of the Board, Engr. Nosa Ukponmwan, the problem could have been Completely overcomed some Eight (8) years ago, if schedules were diligently followed. It was envisaged to continue to multiply by two, the capacity every five year in 1981 to about eight times the initial capacity.

"In 1987 we started off with 5,000 cubic metres per hour; Five years thereafter (1992) we were supposed to increase it to 10,000 cubic meters, Five year again (1997) to 15,000 cubic meters and to increase to 30,000 in 2002 and then to overall double that. We have only now completed the first and second which will take the capacity of 10,000 cubic meters per hour, so that is the constraint but it is quite relieving that we have increased our capacity thus far."(2)

The only area that would felt this impact as of now is Kubwa with all consumers getting a 24 hour full pressure service".

These has prompted me to investigate why the schedules were not diligently followed so as to provide adequate water supply to the city and it's environs.

And which areas would still face the water shortage problem despite the commissioning of the second treatment plant and also when the next treatment plant could be expected as to avoid completely water shortage in the F.C.T.

1.3 AIMS AND OBJECTIVES

- This resarch work is aiming at evaluating the quality of water produced at FCT water board through laboratory test of the Raw water, Aerated water, clerify water, Filtered water, and Treated water.
- It also aimed at checking the quantity of water produced and to analyse whether or not the quantity is adequate.
- Finally Forecaste the future demand.

1.4 SCOPE AND LIMITATION

Water production, distribution and capacity design is a wide field of research, I therefore limit this research work to:-

- Carry out laboratory test on some important factors i.e PH, Temperature, Turbidity and calculate quantity of chlorine iron.
- To campare these test on dry season and raining season.
- Due to time constraint, the researcher cannot take full detailed analysis of the consumption rate of Abuja FCT.
- Able to forecaste the future demand of Abuja FCT, and to justify the efforts made by Goverment in view to attract further resources.

CHAPTER TWO

2.1 REVIEW OF LITERATURE.

As the world approaches the dawn of a new millnium, environmental issues will continue to occupy centre stage in the development debate. Foremost, among these issues will be the issues of water supply which is essential for human life, economic development, social welfare and environmental sustainability.

Currently, the availability of this (water) vital resource is by no means assured for large sections of the world's population. Today, more than One billion people do not have access to an adequate supply of safe water and 1.7 billion people do not have adequate sanitation. Moreover, the poor pay the most for water and suffer the greatest in forms of impaired health and lost economic opportunities. In developing countries (like west African Countries) contaminated water causes millions of preventable deaths every year,especially among children.

Mr. Ismail Serageldin Vice president Environmentally sustainable In his paper Title sustanable management of water resources" published in the common wealth refrence Book (1998) noted that, agriculture is the biggest consumer of water in most developing countries (like Nigeria), and irrigation ccounts for 80% to 90% of water used. In the neor future, availability of water, rather than land, will be the principal constraint to Agricultural production in many areas. Population growth and competing demands for water will make it increasingly difficult to meet future demands for food. Half of the growth in food supply in the past 30 years has come from the expansion of irrigated agriculture and it is estimated that half to two-third (2/3) of the increment in food production in the future will have to come from irrigated land. But it is becoming increasingly difficult to sustain expansion of irrigated areas. For irrigation as in the water sector as a whole, the lowest cost, most reliable and least environmentally damaging sources of water have already been developed, and the financial and environmental costs of tapping new water supplies will increase drama tically. With the lion's share of water going to agriculture, many countries are under pressure to reallocate irrigation water to other uses." (5)

Ismail Serageldin (1998) Common wealth refrence Book said emerging trends, has indicated that we are now approaching a water crisis in several regions, most notably the middle East and North Afica where the supplies of water per capita is 1,247 cubic metres, one of the lowest in the world. Generally a country of region is said to experience periodic water stress when its annual supplies of water per capita falls below 1,700 cubic metres. Today some 22 countries have renewable water resources of less than 1,000 cubic metres, and 18 have less than 2,000 cubic metres. The expected growth of population over the next 30 years to at least eight (8) billion and increase in living standards and economic activity will combine to create an enormours increase in the demand for water. By 2025 as many as 52 counties with some three(3) billion people will be water-stressed.

Furthermore, rapid urbanization have placed unprecedented pressures on water supply and quality. Between 1950 and 1990, the number of cities with population of more than one million nearly quadrupled from 78 to 290, adding some 650 million people. In the next few years, half the world's population will live in cities. By 2025 90% of population growth will have taken place in urban areas, increasing the demand for water of suitable quality for domestic, municipal and industrial use and for treatment of waste. Today in the developed world, industry uses between 40% and 80% of total water withdrawals comparable figures for developing countries are 2-5%. This figure can be expected to grow significantly. Greater industrial use will also lead to more problems of water quality. Income growth will also put pressure on household water use because the rich use water than the poor. In view of these trends, protective measures for managing demand for water will be as critical as investment in new infrastructure." (5)

However, up till date, the water management strategies characterised by policies that are unsustainable at any perspective, economically, socially or environmentally.

In a paper, tittle "Sustainable management of water Resources" written by Mr. Ismail Serageldin Vice President, Environmentally Sustainable Development at World Bank has stressed out Four principal failure of water management policies under the following headings:- (5)

2.1.1 REFUSAL TO TREAT WATER AS AN ECONOMIC GOOD:

A principal costraint in current water management is that most countries refuses to treat water as an economic good. Low value users are allowed to consume large quantities of water forcing high value users to incur steep costs in securing water from lon distances. The result is waste, depletion, less that fully reproductive investments and sometimes, ecological disaster.

2.1.2 EXCESSIVE RELIANCE ON GOVERNMENT FOR SERVICE:

Water has always been considered a strategic resource a public good, so it is not surprising that governments have assumed central responsibility for it's management. Nonetheless, while reliance on market forces alone is not possible or even desirable.

Mismanagement of water on the part of the government has led to serious misallocations and waste therefore, in order to meet the long-term priorities for improved management of water resources, especially the provision of water and waste water services, it will be necessary to harness private sector investments. An important principle in such - public partnerships will be cost recovery for both the use of water resources and the provision of services.

2.1.3 **FRAGMENTED MANAGEMENT:**

Water management is fragmented among provinces, sectors and institutions, with little regard for conflic or complementarities between social, economic and environmental objectives. There are multiple agencies for different users, For example, irrigation, municipal water supply, power and transportation and other inter-sectoral interactions within an independent system are usually ignored. issues of water quantity and quality and concerns about health and the environment are treated seperately as in the management of surface and groun water. When individual provinces have jurisdiction over water in their territory, the same water source will be developed without considering the impact on other provinces.

Similarly, domestic, industrial and commercial supplies often are provided by local Governments that are not co-ordinated with provincial or national water departments.

This result is often excess and unproductive investment with different agencies developing the same water source for different uses, fragmented management among countries where on country will develop a water source without consulting or even considering the impact on other countries, also has economic consequences and potential for igniting international conflict.

2.1.4 INADEQUATE RECOGNITION OF HEALTH AND ENVIRONMENTAL CONCERNS

Scarcity of water and unavailability of safe potable water are jeopardising the lives of millions of people in the world's developing countries. The health consequences of service shortfalls make water a life and death issue for millions of people particularly the poor.

Water borne disease accounts for for eight (8%) of all the disease in developing countries (affecting some two billion people annually), and for 90% of the 13 billion child deaths each year.

It is important however to recognise that the poor are victims of bad water managemnent decisions and suffer the most in terms of impaired health and lost economic opportunities.In a similar development, an action agenda for the new millenium was set up, in terms of poor water management which are reflected in a global census, at the 1992 United Nations Conference on the Environment and Development (UNCED) in Rio de Janeiro in view for policies which recognise water as an integral part of the ecosystem, precious natural resource and a social and economic good. (5)

The hallmarks of the (1998) action agenda includes:-

2.1.4.1 **COMPREHENSIVE CROSS-SECTORAL APPROACHES:**

The cornerstone of the new approach is that water policies and investment should ensure the sustainability of the water environment for multiple uses. These approaches are, however difficult but are necessary to establish.

The following points can be considered important:

a - Better performances by providers of water services and more efficient use of water among different users and greater conservation. Performance and effeciency can be enhanced through proper incentives, the most important of which are price-based. Ideally water should be priced at it's opportunity cost - it's value in the best alternative use.

Proper pricing for water is not sufficient to ensure effecient allocation and improved services. The failure to collect and recover cost is also a constraint almost everywhere, especially in the developing world.

b - Decentralisation, especially in retail distribution of water, makes it easier to ensure financial autonomy and the involvement of the private sector and water users in water management; smaller, locally managed institutions, whether public or private have more effective authority to charge and collect fees without political inteference.

c - Prescribing and encouraging the participation of stakeholders - individuals and institutions that would be affected by decisions about water resources management is beneficial in a number of ways. Stakeholders participation in the formulation and design of water projects had served to incorporate local knowledge and circumstances leading to better design. Participation has also generated a sense of ownership for projects which helps build the social and political cohesion that is necessary for long term development planning. It has also encouraged greater cost sharing and better maintainance, promoted equity, built local capacity and enhanced transparency, accountability and intitutional performance.

2.1.4.2 **ENVIRONMENT AND HEALTH:**

Changes in water management that put together reliance on the private sector, autonomous utilities and user participation promises to considerably improve a country's ability to protect the quality of it's water and land and promote the health of it's citizens.

Cities, industries and small municipalities alike can be encouraged to reduce their discharges of waste water by applying surcharges to water supply fees:

With community participation and organisation for user charges, small towns can also find it cost-effective to treat effluents.

2.1.4.3 **MOBILISING WOMEN:**

Women are important ecosystem managers both in urban and rural areas, and make decisions concerning the use of water resources. They are the primary surveyors of drinking water supply and play a key role in promoting hygiene, sanitation and human welfare." (6)

Vice president, Atiku Abubakar, in his paper presented at the second international conference of the Nigerian water supply Association held in Abuja, published by FCT water Board, ABUJA WATER NEWS VOL:2. NO.7 Oct - Dec 1999, it was noted that;

"Substantial investment is required to bridge the gap between the supply of water and the high demand as a result of population growth and rises in living standards.

In contemplating the desired reform with the objective of improving access to efficient and sustainable water supply as a "free social service" which even in present day realities it is promised to the citizen without cautious qualification.

Vice president, Atiku Abubakar (1999) noted that, the reality here is that since it costs money to source water, purify it, and make it within easy reach, it can not be said to be free. Rather in those past years the cost of the service was built into the tax systems or in few cases billed on the spot of collection. The supply in those days was predominantly from the simple public stands pipes and not complex house connection while the consumption standard was no better than 20 litres/capita/day. (3)

It is conventional wisdom that if the service is effecient and cost effective, the cost to the consumer will ultimately be relatively tolerable for a guaranteed service, but where these considerations are negleted service becomes poor and expensive especially to the disadvantage segment of the society.

President Olusegun Obasanjo, in a conference with the stake holders in water sectors, and publish by Abuja water news May 2000. said that, the Federal Government was "Keen to assist in funding the water sector to ensure that majority of Nigerians get access to clean and potable water". According to him, government has already unfolded a water policy in which 60% of Nigerians would have access to the resource by 2003. Already less than half of the population is covered. By 2007 the coverage would extend to 80% while the entire people would be covered by 2011. This policy underscores the Federal Government committment to the funding of the water and sanitation sector as it centres on the objectives of sufficient potable water and adequate sanitation to all Nigerian in an affordable and sustainable manner through participatory investment by the three tiers of government, the private sector and the beneficiary community. (2)

In their remark, the world Bank representative (1998) stressed the Bank's readiness to engage in policy dialoque and accompany this with small towns water supply and sanitation pilot project. (3)

The African Development Bank (ADB) (1998) also assured its continual funding of projects based on it's statement and policy in the sector designed to foster approcches that are people oriented, sustanable and earth-friendly. (3)

The representation of Economic commission for Africa. (ECA) 1998 equally expressed the commissions readiness to provide advisory services and techmal assistance to Nigeria. (3),

The UNICEF technical representative (1998) praised the government for the positive steps it had taken in poverty alleviation and emphasized their readiness to work with the government and most especially in rural areas to achieve wide coverage on education, water supply and sanitation." (3)

The European Union (EU) (1998) on their part, re-affirmed their commitement to development efforts in Nigerian and the Money earmarked for Nigerian as well as a needs-assesment-study that would be carried out soon to determine areas of allocation and a quick-start package involving rural and small town water supply and sanitation in virious states that hopes to commence immediatety. (3)

Other donor agencies - JITA, DFID, NORAD, KFW also pledge their willingnex to assist Nigeria actualize its dream of "water-for-all in the nex few years. (3)

Abdulkadir (1998), civil Enginering department of the Federal University of Technology Minna, Nigeria caried out a resarch work on the performance and efficiency of Minna(Niger state Capital) water treartment plant. He called on government to even allow 30% of it's annual budget to be spand on the production of potable water. (1)

Finally, quality and quantity of water produced at any level still remain the problem to be solved in most developing countries (like Nigeria).

2.2 CRITERIA FOR POTABLE WATER.

In order to be used as healthful fluid for human consumption, water, must be free from organism that are capable of causing disease and from Minerals and organic substances that could produce adverse physiological effects. It should also be free from apparent turbidity colour and odour and from any objectionable taste.

Furthermore, good drinking water should have a reasonable temperature; water meeting all this condition is termed "potable" meaning that it may be consumed in any desired quantity without for adverse effects on health.

Below is water quality problem and their potential solution.

TABLE 2.1 WATER QUALITY PROBLEM

Problem	Possible Cause	Polential Solution
Taste and odour	- High chlorine residual - Biological (algve) growth - Dead end in main or tank	- Use breakpoint chlorination or lower chlorine dosage - Chlorinate - Flushing or elamet dead end
Turbidity	Silt or day in suspension calcium carbonate iron oxide precipitate	Floshing main's or proper operation of tratment process
Colour	Decay of vegetable matter microscepic organism	Chlorination chlorination
Positive coliform	- Contaminated distribution system	Locate and remove source
Result	Negative pressure in main chlorine feed rate, main	Repair main, increase positive pressure

Meanwhile, water can be polluted in one of the following ways:

1) By Human Or Animal Origin: This is by either remains or from the waster resulting from their metabolism. This takes the form of suspended matter organic, bacteria and or virus.

2) Industrial Wastes: These are poluttion such as vegetable waste mineral and organic carinogens, and sometimes radioactive material depending on the primary products being used in the factory.

3) Agricultural Pollution: These are from fertilizers and chemicals beingused in weeding (such as herbicides and Pesticides).

4) Accidental Pollution: This occurs more in advance countries where certain chemicals which are injurious to animal and plant life, though well guarded find their way in to surface and ground water.

2.3 DRINKING WATER STANDARDS

The most widely used standards before 1983 were the WHO (World Health Organisation) international standard for drinking water first published in 1963, 1968 and 1971. These have been revised and were re issued in a new form in 1983, now re-tittled "Guidelines for Drinking Water Quality". The W.H.O. 1971 international standards are also produced since they have formed the basis for many national standards. The WHO also published European standards, the latest edition which was issued in 1970, but these no longer apply as they are merged in to the WHO 1983 guideline.

Within the European community an EC Directorate issued in 1980 on the quality water intended for human consumption applies to the member states. The provisions of this EC directive can be seen in the appendix in table 2.

Other standards of importance are those used in the U.S.A. formerly issued by the US public health service, now superseded by the Drinking Water Regulations published by the US Environmental protection Agency (E.P.A.) 1977. The updated versions of this was reflected in many of the provisions of the second issue of WHO standards in 1963.

Many other countries have their own national standards, most of which are based upon ther WHO international standard of 1958, 1963, 1968, or 1971 with only slight modification.
The W.H.O. International standard are given in the appendix

2.4 COMMENTS ON THE USE OF STANDARDS:

The widespread use made of the WHO international standard shows their considerable usefulness.

However, neither those standard nor any other should be applied as the sole critarium for determining whether or not water should be used or if used, how it should be treated. It is sometimes better to used water that is bacteriologically safe despite the fact that it contains some excess of non-toxic material such as iron, chloride, or hardness, then to use a water-borne disease, even though it otherwise complies with standard.

Sometimes physical and financial constraints will make it impossible to procure a water which ccomplies in all respect with the WHO or other standards. Efforts should however be made, so that the safest water is produced.

Two factors must be born in mind:

(1) It must be expected that continous development of standards will occur in the future as more becomes known of the effect of trace compound in water upon health.

(2) The important of palatibility must be emphasized. This is common especially in poor or under-developed area where the public can still gain accers to inferior sources of water liable to carry disease. By applying WHO standard the supply can gain reputation for being good, both for palate and for health of consumers, so that it (water) is wanted and people are willing to pay for it; those helping water undertaking to be financially self-suffecient.

2.5. DEVELOPMENT OF TREATMENT SYSTEM:

The development of treatment system for water, require a fundamental understanding of phical, chemical, and biological phenomenon on which the various treatment units and processes are based. Over years, methods have been developed for the treatment of water. In most situation, a combination or sequence of methods will be needed. The specific sequence required will depend on the quality of the untreated water and the desired quality of the product. Although treating water is relatively inexpensive on a per-cubic-meter basis, these is little opportunity to modify water quality directly in most natural system such as streams, lake, and ground water because of the large volume involved.

The contaminants in water are removal by physical chemical and biological mean. The specific method use classified as physical unit operation, chemical unit processes and biological unit processes. Although several of this generation and processes are combined in most treatment system of the treatment of river water involves screening, congulation/flocculation, sedimentation, filteration and disinfection, so it require softening for hardness removal.

The typical flow sheet for complete treatment of the Usuma Dam treatment plant as shown in figure (i) below:

2.6 WATER TREATMENT

The method used for the treatment of water are related to the contaminants in a given water supply. These methods used can be classified according to the nature of the phenomena that are responsible for bringing about the observed changes. The commonly used water treatment method are physical operation and chemical operation processes. Since the contaminant concentration is low, the biological processes are not used in the treatment plant. Meanwhile, the physical unit operation is brought about through the application of physical forces. This include screening, mixing, gas transfer, sedimentation and filteration, all these are physical unit processes. And in terms chemical unit processes which is the removal or treatment of contaminants is brought about by addition of chemical or by chemical reactions, e.g. chemical and disinfection are two important examples.

TABLE 2.2 UNIT OPERATION FOR WATER TREATMENT.

Operation		
Screening	Physical	Course screen are used to to protect pumps from floating solids. Fine screens
		are used to remove floating and suspended materials.
		Closed to filter out fine impurities such as alge, salt etc Use to add and
Micro screening		remove gases that may be under or super saturated with respect to the water.
		Air stripping is used for removal of voc.
		Used to mix chemical and gases that may be added for treatment. Creation of
Aeration(gas		velocity gradient by gentle mixing to promote the aggregation of particles.
transfer)		Used to remove particle such as silt & sand or flocculated suspensions.
		Used to filter the residual solid that remain in water after settling.
		Used for the removal of natural organic compound & flue, also used for water
		softening.The process of adding & initial mixing of chemical used for the
		chemical treatment of water by precipitation.
		Used to destroy the pathogenic organism that may be present in natural water.
		The removal of dissolved toxic species such as calcium & magnesium (hardness)
Mixing		by adding chemical that bring about their precipitation.
flocculation		Use for the selective or complete removal of the dissolved eathodic and
		anionic ions in solution.
		Used for the removal of a variety of organic compounds such as those
Sedimentation	Chemical	responsible for colour, taste and odours.
		Used to oxidize various compound that may be found in the water such as those
		responsible for taste and adour.

THE PROCESS OF TREATMENT PLANT:

2.7.0 **INTAKE SYSTEM:**

The raw water to be treated is supplied from the lower Usuma dam which supply the Federal Capital Authority. The two water work constructed are open channel, flowing from west to the east of the treatment plant.

The intake room is build beside the dam which consist of two large rooms, the wet-well and drywell-well. The wet well has a large inlet value through which the raw water takes it way. While, in the dry well which consist of four centrifugal pumps each with electrical motor that aids the rotation of the shaft with help of the rotation of these shaft the raw water is converged to the treatment plant. The type of intake system use by the treatment plant is called pile crib system make up of concrete building.

2.7.1 **DISTRIBUTION CHAMBER**

As the raw water is pumped in by the electric motor from the intake is directed to the distribution chamber via aflow water. The flow meter determine the dosage of the chemical.

The distribution chamber is of two section, the first section, the first chamber is a chamber where pre-chlorination take place. Chlorine is supplied to the water counter currently (the water comes in through the bottom from the intake while the chlorine from the chlorine chamber room mixes with the water at the top). The essece pof the chlorine supplied is to eliminate or kill some of the bacteria e.g agae present in the water. When chlorine is added to water two reaction take place, which are hydrolysis and ionization reaction.

The hydrolysis reaction is;

$CL_2 + H_2o$ <--------> $HOCL + CL + H^+$

Chlorine gas — hydroclorous acid

The ionization reaction is;

$HOCL$ <------------> $OCL^- + H^+$

Hydrochloride acid — Hydro-chloride ion

Liquid chlorine is obtained in pressure containers and is applied to the water using a device known as chlorinator. In the process of pre-chlorination it also improves coagulation and reduces the load on the filters.

At the first section of the contribution chamber the raw water is allowed to pass through two gate, to the other section where alum i.e Aluminium sulphate ($Al_2\ (SO_4)_3$)is added to the water. Alum [$Al_2(SO_4)_3.18H_2O$] is the most common coagulant which react with the all catinity in water to form aluminium hydroxide flow according to the following reaction:

$$[Al_2(SO_4)_3.18H_20+3ca(Hc0_3)_2 \underset{<---}{\overset{---->}{}} 3caS0_4+ 2Al(0H)3+6c0_2+18H_20.$$

Aluminium sulphate	Calcium bicarbonate	Calcium sulphate	Aluminium hydroxide

The process is also counter-currently though aluminium sulphate is added at the distribution chamber. Flucs is not allowed to settle in this chamber, instead it is directed to the flash mixer, which is with the aid of the gravitational force.

2.7.2 FLASH MIXER

The flash mixer has it's top designed in circular form. It consists, the big and the smaller circles. The big circle is slightly below the smaller one with a spy way between them. The water coming through the distribution chamber enters through the bottom of the flash mixer to the smaller chamber, if the water is full the excess one spy through the spy way to the bigger chamber. The flash mixer is common in the modern treatment plant and they are found in both plants constructed in lower Usuma dam treatment plant.

2.7.3 THE CHEMICAL REACTION THAT TAKE PLACE IN THE MIXER

When the alum is pass into the solution a series of reaction takes place and these contribute a process known as hydroxyl. As an hydroxyl ions are consumed by Al^{3+} the PH of the water decreases, that is to say positively change ions that moves about in the water are attracted by billion of negative charge suspended particle.

In the mixer the essence of adding calcium hydroxide [$Ca(OH)_2$] is to improve the PH and clarifies the water to make it colourless, odourless and tasteless and the reaction that occour when $Al_2(SO_4).18H_2O$ is added to water makesw the water acidic as such $Ca(OH)_2$ added neutralizes

2.7.4 FLOCCULATION TANKS:

The flocculation tank is designed in zig-zig form, it has the inlet and the outlet pipe. A PH meter is fixed at the inlet of the tank and it seal the PH of the water coming from the flash mixer. The water coming at a flow rate of 0.3 m/s and at the outlet the flow rate is 0.2 m/s, due to the zig zard arrangement of the tank it reduces the speed of the water thereby allowing the formation of the flucs, as the speed is decreasing ttoward the outlet it makes the flucs formed not to be break inside the bank.

2.7.5 **FORMATION OF FLUCS:**

The positively changed ion is attracted by negatively charge particles to form a neutralization reaction. The particles that have been formed collide with one another and they stick together, this is to collide with other particles to form a bigger particle. As this sticking and growth of size continues until a certain size and weight is reached that is the up most of the water could no longer hold the weight of the particles. So that at this point, the particles will be allowed to settled down. With the provision of baffled bring the zig-zard movement of water and make the easier formation of flucs.

2.7.6 **SEDIMENTATION TANK:**

This is the section where the particle in the raw water from the river settle down. The type of sedimentation provided is called counter-current laminar seperator. The shape of the tank is in pyramid shape with it base on top and the opex at the bottom, the total surface area is 4,062m^2. The base is packed with laminar packages which incline at an angle of 60 degree to the horizontal. The reason for this arrangement is to prevent the particle from settling at the top instead it goes down.

The main objective of the laminar packages is to increase the surface area of sedimentation thereby conserving land base where the tank is constructed and for every tank it ccontains 30 laminar packages. Therefore it compose of 60 packages which gives the sedimentation velocity of the removal of particles at 0.5 m/s at the design flow rate.

2.7.7 SLUDGE REMOVAL

The side of the settling tank hoppes being pyramid in shape and they are at angle 600 with the horizontal, which is within the minimum slope down and full without slicking. The coming velocity of water enable the removal of sludge through a pipe and valve under hydrostatic head without draining out the tank.

2.7.8 DISLODGING

Frequency and duration of dislodging from the bottom of sludge formed. This operation commence once every. three (3) day. The greater quantity of the rludge which can be maintainred is the tank the better, threrfore, the preadure of dislodging take place only when the level of sludge blanket is at the upper limit and to remove the sludge in to bring the level down to the limit. So the process is that the inlet value is to the tank is closed and the outlet value is opened immediately for a requirement period of about six (6)minutes, But in some cases it is found thatthe lost of water can reduced by allowing the tank to stand for most time of about is to 30minutes before disloging, which is to allow some corrcentration to take place in the trooper.

2.7.9**FILTRATION SECTION:**

The filtration is the process of removing turbidity (suspended particle) form water by passing it through some porous filter media such as sand this filter is made of sand grain, underneath each filter consist of seven (7) nozzles and covered with a layer of 1m thick. The sand filter the particles that refuse to settle in the sedimentation sections are serve while the nozzle sieve the particles that able to pass through the sand. The filtration section of five(5) valves which are inlet valve, outlet value, the drainage valve, air backwash valve and water backwash. When water passes through the filter suspened particle and flocculent material come in contact with the sand grains and aclhers to them, this reduces the size of the water passage and draining action reoults at this time more and more material are trapped in the filter bed and the hyohaulic head loses through the bed become sucessive.

2.7.10**BACK WASHING**

As the amount of solid retained in a filter increase to bed ponosity decreases. At thesame time head loss through the bed and shere on captured flucincreases, before the head lose bulb to an unarreptable level, backwashing is required to clean the filter bed. The process of backwashing in a follow, the falling of rapid filter in varhed by a reverse flow of water or air-water mixture in this case the water use in filtered water. Before washing the repply of initial level in the filter in drop down below the edge of the bough. The supply of wash water iss started into the bottom portion of filter. The water enter the distributing system of the filter. The water rprcad evenly over the filter susface and rises through the falling at the rate which is controled so an to raise to particle of the filter and maintain them in the suspeneded state grain particle suspended by wash water collode continuosly with one another so that the impurity particle struck to them are robbed off and arecarsied out of wash water into the trough and them into the control channel and later back to lower usma dam, the process contince until the water in the trough becomes transparent.

The process of backwashing in the lower usuma dam treatment plant is automatic. This is done by pressing some bottoms on the control deck of the particuler filter. The process involves three(3) stages. First the sand by bottom is processed and all the valves become clused and this take about 15 minutes, after about 15 minutes, the generation bottom is pressed to give way for backwashing. After that the phase One (1) bottom is pressed and this open the drainage valves to drain the water in the filter and this takes five (5) minutes. Then the phase two (2) valve is pressed and open air backwash valve and air is pumped from the high lift to the filter to agitate the dirty particles. Then the phase three (3) bottom in presses and this open the water backwash valve, and water is purped from the highliht to the filter and away the dairty through the drainage valve.

Meanwhile, is more water is forced up through the sand bed the pressure under individual grain of the filter media becomes greater. This pressure continrally increase overcomes the weight of the particle of the filter media. This point is known as the point of Elvidity. At this point, the particle rises and the filter bed start expanding. In the filter bed, space is provided called the back wash space, which permit the expansion during backwashing process.

2.7.11**POST CHLORINATION**

This is usually refers to the addition of chlorine to the water after all other treatment, it is very important of the prechlorination did not take place before the start of the processes. After the post-chlorination it take at least 30min before the water is pumped to consumer.

2.7.12 THE CHEMICAL ROOM.

This is an important place where chemicals are prepared and dosed into the turbid water from the intake in the distribution chamber. These chemical are alumsulphate (Al2Cso)3), line (caCoH)2) and Sodium Alginate (NaAlg). One to lost and non availability of the sodium alginate is not used. Since it is abserve has no much effect on the find quality of the water obtained after treatment.

There are these lime storage tanks each with a capacity of $10,000cm^3$ filled with a mixes and on exust the line solution is prepared by the additions of 8 bags of lime 25kg each into 9800litres of water in each storage tank, while adding the line the mixes and exhausted use sterted from the motor control centre (mcc4) in the chemical room. The exchansted such out the dust that rise duting the dosage of the line, and athe mixes continuosly mixes the line solution with the help of an impultes filtered to it there are three dosing pumps responsible for dosing the lime to the distribution chamber. Two of those work of a lime while one is left as stand by in case of any emergency. Each pump has a maximum stoke of 10, but the stroke is adjusted to give the required flow rate, which depends on the turbidity of water. When the lime is completely or almost used up, another dosage operation is carried out as before.

Meanwhile, the sodium Alginate tank is also the which also has the same capacity an that of lime, but it is made up of plastic instead of sced and this is because it reads with steel, the dosing pump are thesame with that of the line except that the pipes that lead to the distribution chamber are plastics. the tanks are erutrolbed or operated from the motor control centre 5(mcc5). The sodium Alginate dosage will not be dircussed since it is not used at present. Alum sulphate solution Al2 (SO4)3. 18H20 is prepared in an under ground tank by the addition of 100 bays each containing 50kg of Al2 (504)3 into 45000 litres of water from the clear water tank. The tank is filter with two recirculation pump, that continuously recivculate the solution to given an homogenous solution. From hare it move to the dosing pumps that pumps it to the distribution chamber. Two of these pumps work at a time, while one is stand by the motor of the alum-sulphate tanks are operated and controlled by mcc6.

2.7.13 THE CHLORINE ROOM

This is the room where chlorine is dosed into water. These are about 10bags cylinders each contains chlorine gas under presses. Out of this only one is used while the rest serve as reserves.

When the chlorine is to be dosed, those in charge of the pump, in the highlift are notified to start the booster pumps which pump water from the clear water tank to the chlorine room. Then the nob on the gas cylinder is spooned to allow chlorine gas pass to the gas-liquid absorption apparatus in the next room. The flow rate if chlorine is adjusted pending on the amount needed at that particular time. The chlorine gas dissolves counter -currently in the water from the highlift one pipe carried. The dissolved chlorine to the distribution chamber for the pre-chlorination which result into partial disinfection of water and oxidation of ion maganese and organic melted. This is primarily present the proliferation of algae in the equipment. The flow rate of chlorine in pre-chlorination is 8.0kg/hr.

The post chlorination dosing pipe is filled to the filter gallery outlet at Flow rate of 4.2 Kg/hr.

CHAPTER THREE

3.0 METHOD OF DATA COLLECTION

The method of Data collection used in this reseach work are as follows:-

1) Personal Interview with FCT water Board Personnel
2) Personal Interview with the consumers
3) Laboratory Test
4) Data reports and other Publications.

3.1 PERSONAL INTERVIEW WITH WATER BOARD PERSONNEL

Most of the Data concerning the activities of FCT water Baord activities were collected through personal interviwe with the following personnel

- The officer incharge of the National Water Rehabilitation Project. He provided information regarding the management aspect of the board.

- Interview with Lawal, has provided useful informationregarding domestic and commercial consumption. He provided me with the billing system of the board, the number of consumers in the Territory. He made mention of how they raise revenue and use it to pay the Cost of treatment, Maintenance and even pay staff salary and welfare. He suggested the way at whcih Government would solve the acute water shaortage in the FCT

- (Area Manager Lower Usuma Dam). While at the Dam Engr. J. B. Anto took me round and explained the step-by-step operation of water treatment processes thereby also explaining the dosage of both Aluminum sulphate (Alum), Lime and Chlorine used to the treatment plant and the areas at which they are serving.

3.2 HEAD OF LABORATORY LOWER USUMA DAM

She provided me with result of previous years on physio-chemical properties of the water of which I make a sampling of 2 days result during dry season and 2 days results in raining season.

3.3 INTERVIEW WITH THE CONSUMERS

I selected some officers at area I Garki and asked them about the quality and quatity of water in Abuja FCT. The responed was that the quality is O.K but the quantity is not adequate because most of them were staying at the satelites town of Nyanya/Karu and Mararaba in Nasarawa state where a 24hrs full services was not observed.

3.4 LABORATORY TEST

This formed the basis of this Research work the quantity control of the water can only be achieved through laboratory test. The result obtained from Laboratory test will help in evaluation and Analysis. However the important physical and chemical quantity tested are: PH, Turbidity, Temperature, and Residual Chlorine. The Step-by-step procedure of these test are shown below.

3.5 DATA REPORTS AND OTHER PUBLICATIONS

A number of publication has been consulted in conducting this research work; and they provided most of the Data used in this work. the publication are Abuja water News, Journals and Textbooks available in the F.U.T. Minna and Kaduna Polytechnic Libraries

3.6 SOURCE OF ABUJA FCT WATER SUPPLY

3.6.1LOWER USUMA DAM

Currently the lower Usuma Dam remains the primary source of water supply to the city and it's enviros. It has a reservoir of a maximum capacity of 100million cubic metes and is equipped with water treatment plant having a designed capacity of 5,000 cubic meters per hour. The second treatment plant which is a mimor image of the existing treatment plant has been constructed and commissioned on may 25,2000 having the same designed capacity of 5,000m^3/hr but only half of this volume is being supply together with the first plant due to some pipes that yet to be connected.

This Dam is supplying about 90% of the water at F.C.T.

3.6.2 JABI DAM

The jabi water works was designed to provide temporary water supply to the new Federal capital city (FCC) Abuja only, before the commencement of the usuma Dam water works.It provides 300 cubic meters per hour. The water is pumped in two directions. It served the 500 cubic meters tank in life camp and 2,700 cubic meters tank on the hill in Asokoro.

3.6.3 KUBWA WATER SUPPLY

Water supply in Kubwa is from 12000m^3/hr storage tank located on high ground behind the town. The tank takes its water source directly from the water tank at the Usuma dam. With the additional treatment plant at the dam, kubwa is the first to felt the impact being it closest to the dam with all the consumers getting a 24 hour full pressure sevice. There would be also a marginal increase water supply to wuse II and the ministery area around the Golf course maitama.

3.6.4 KARU/YANYA WATER SUPPLY

Water supply in Karu and Nyanya is from a storage tank of capacity 10,000m3 located on the karu hills. The tank takes its source from the asokoro tank (tank 4). The supplies is by giravity.

3.6.5 AIRPORT WATER SUPPLY

The Abuja international airport is serviced by a $10,000m^3$ storage tank also located at the curport. The tank takes its water source from the usuma Dam through a pipe network.

3.6.6 GWAGWALADA WATER SUPPLY

The gwagwalada water treatment plant serves consumers in Gwagwalada the plant has a capacity of 180 cubic metes per hour and has been in operation since 1981.

3.6.7 RURAL WATER SUPPLY

The federal capital territory has an estimated number of 800 rural communities with an average population of 1500 each. At least 3 water points are recommended to serve each of these communities.

The rural development department has taken some measures to ensure adequate water supply by:

(1) Repairing broken down water points.

(2) Provide about (5) five motorized mini as water schemes to 25 rural communities.

(3) Some feasibilities studies and inverstigation for the siting of treatment plant for kuje town.

However the list of boreholes and some motorized miniwater scheme are given in the next page please.

TABLE 3.1

LIST OF SOME BOREHOIES

LOCATION OF BOREHOLE

S/NO	VILLAGE	AREA COUNCIL	REMARKS
1	Kitipa Gawu	Abaji	Functional
2	Dutsen Alhaji	Bwari	-
3	Ushaffa	Bwari	-
4	Anagada	Gwagwalada	-
5	Tunga maje	Gwagwalada	-
6	Angwan Dodo	Gwagwalada	Non Functional
7	Gurfata	Gwagwalada	Functional
8	Kiyi	Kuje	-
9	Kuje seminary	Kuje	-
10	Shoda	Kwali	-
11	Leley	Kwali	-
12	Yangoji	Kwali	-
13	Karon majigi	Municipal	-
14	Sauka	Municipal	Functional

LIST OF SOME MOTORISED MINIWATER SCHEME (MMWS)

LOCATION OF MMWS

S/NO	VILLAGE	AREA COUNCIL	REMARKS
1	Agiyana	Abaji	Functional
2	Nuku	Bwari	Non-Functional
3	FGGC	Bwari	Functional
4	Paikon kore	Gwagwalada	Functional
5	Dobi	Gwagwalada	Functional
6	Ruboci	Kuje	Non-Functional
7	Kwali	Kwali	Function
8	Yangoji	Kwali	Non-Functional

3.7. LOCATION OF ABUJA (FCT) WATER TREATMENT PLANT.

The lower Usuma Dam being it the source of Abuja water supply a treatment plant has been constructed (1st and 2nd). It is located in the North - East part of the city at a distance of 40km. It is on the high attitude areas of the territory and is sited on a virgin location and where there is no is no human activity ensuring non pollution of the environment and free from industrial impurity.

This can be verify when conducting the P.H. and turbidy test in the subsequent chapter.

3.8 **WATER SUPPLY SYSTEM**

The Flow chart

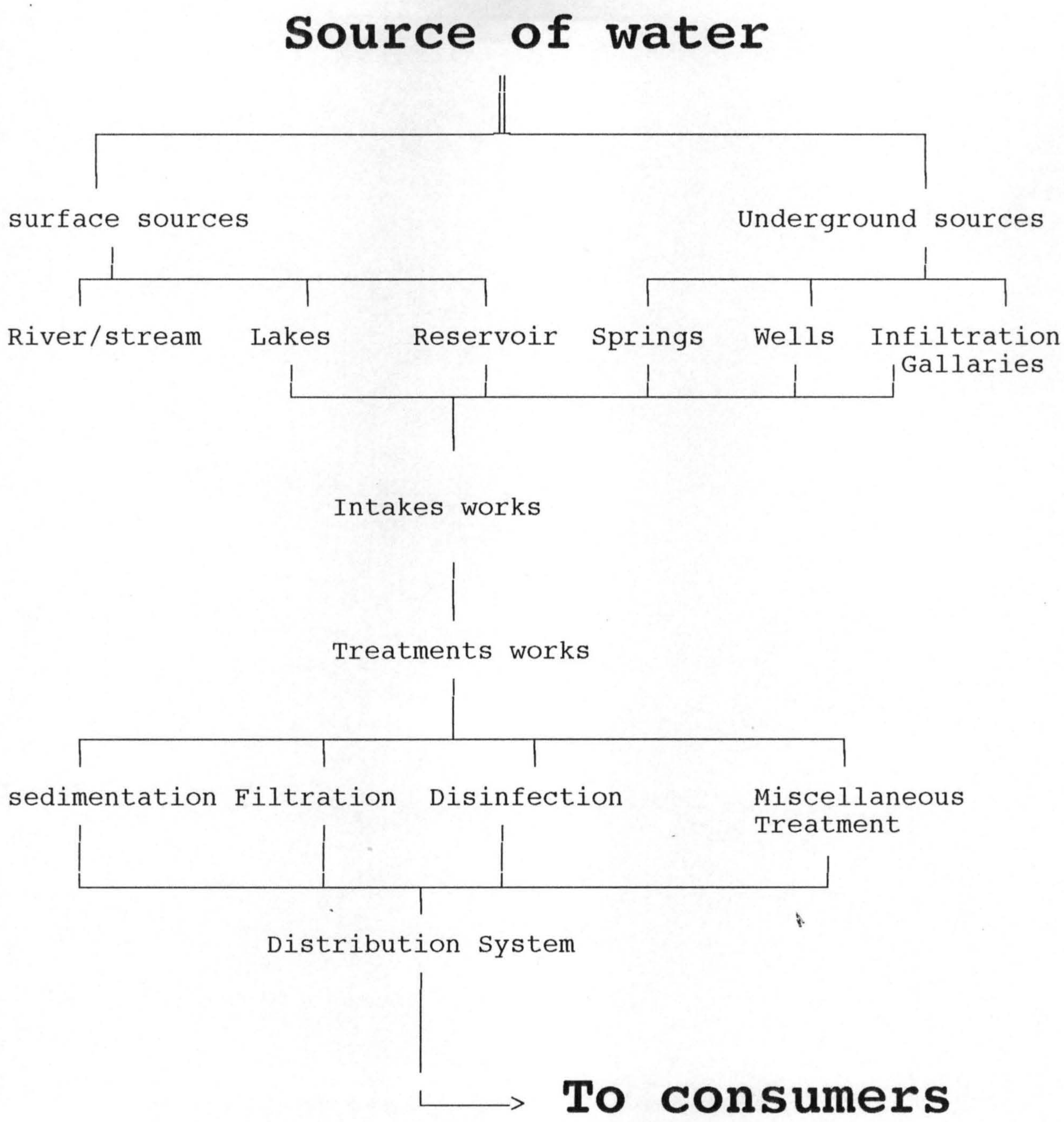

Fig. 1.

The source of Abuja water supply is from the lower Usuma Dam. The water (Raw) is collected by the intakes room i the dam. It has two large rooms, the wet well and dry well.

The Raw water contains suspended and dissoived impunities as well as harmful bacteria. The water from the in take is first taken to tratment plant far treatment through Aeration chamber where oxygen is introduced. Aluminium sulphate (Alum) and lime (calcium carbonate) are added as a coagulants.

It is then passed to sedimentation tank where the suspended solids are removed by allowing them to settle down in sedimendtation tank. The settled water is then discharged away through a pipe to either the dam or for another treatment (in the case of where the water is not too turbid) or discharge away.

The other process involves pre-chlorination (i.e addition of chlorine). The cocentration of chlorine needs to be ensured in order to have residual chorine at the end of the treatment. The concentration is about 4 ppm in distribution network and about 2 ppm at the consumption point (post chlorination) as may be seen in the subsequent chapters.

Chlorination is vital to the purification of drinking water especially microbiological quality. The chlorine used in both the two treatment plant at the dam is chlorine gas which helps to removes all micro - organism that are injurious to human health.

The next is filtration, which removes the colloidal particles then to final treatment which is post chlorination which helps to kill excess micro-organis that may be one way or the orde present in the water, to correct P.H value. Then the water is at this point pushed to consumers; Along the distance from the dam to the city also there is a booster station for chlorine dosage, to ensure purity.

At all the stages above, P.H temperature and turbidity tests were carried out, which can be seen in the next chapter (i.e test on raw water, Filtered water, clarify water and the treated water respectively).

3.9 QUALITY OF RAW WATER

The "raw water" refered to the water before treatment, that is the water from lower Usuma Dam. it may appear drinkable by mere looking if not of the believed that it may contain some dissolved oxygen, carbondioxide, inorganic matter and few bacteria

The level of impurrities of this water can however be determined before treatment, this was done in the laboratary where P.H test, turbidity, Temperature and some other chemical propertics of the water were carried out (e.g chlorlde lron, dissolved oxygen).

However the step-by-step determination of the chemicals present in the water is beyond the scope of this project; but data was collected on these properties for comparing with W.H.O international standard.

These test were carried out during the dry season and also raining season to enable me check the effects of rain water. The apperanace colour, odour are however unobjectionable.

3.9.1 P H

This indicates how acid or alkaline the water is so that it can be neutralized to international standard. The acidity of a water normally can be through or interm of concentration of hydrogen ion present in it. This can vary ovar a wide range of low concentrations and expressing it in logarithmic terms result in a reasonable range of number.

Thus, the more acid a solution, the larger the hydrogen ion concentration and there by lowering the P H value.

The P H of a water and the ease with when this is change by the addition of acids or alkalies depend on the relative and total concentrations of the different substances already present in it.

A more acid water has a P H of less then 7 and a more alkali water has more than 7.

3.9.2 **P H TEST**

EXPERIMENT: PH Determination

AIM: To determine PH value of the Raw water

APPARATUS: PH metre, buffer 4 and buffer 7, beaker

<u>METHOD:</u> Collect a sample of raw water in a beaker and adjust or standardize with buffer 4 (for acidic). Then insert the electrode in the solution for some miuntes and take the reading from the meter.

The test was carried out both dry and raining season the result is as follows:

5th JANUARY 2000 PH = 6.8 ┐
>dry season
6TH JANUARY 2000 PH = 6.8 ┘

ON RAINING SEASON

7 AUGUST 2000 P H = 6.9, 6.8 for firts and second treatment plant respectivety.

On 21st AUGUST 2000

P H = 6.9, 6.8.

The same procedure was performed for the Aerated water (AW), Clarify water (CW) Filtered water (FW) Treated water (TW) respectively, thus PH value found.

Table 3.2&3.3however gives the values for both dry season and raining season:

3.9.3**TEMPERATURE TEST**

The measurement of temperature is necessary in the purification of the raw water from the dam. The temperature of a water has an influence on its turbidity, therefore it is necessary to maintain and control it.

Here, the temperature test was carried using the same PH meter which has provision for it.

The electrode is inserted in the water deeply and the reading taken about 23.5^{0}C in the dry season and 24.5^{0}C during the raining season.

3.9.4 TURBIDITY OF THE RAW WATER

Turbidity is the amount of suspended solids present in the water. The amount of turbidity increases with time i.e when it is raining season, the turbidity use to be high, while during dry seasem the turbidity is usually very low due to the amount of dissolved in-organic matter in the water.

EXPERIMENT: Turbidity measurement Aim: To determine the turbidity of the raw water.

APPARATUS: Turbidity meter, water bottles, curvettes.

PROCEDURE: The water sample is carefully collected in the curvettes, ensuring that no spillage on the side of the curvette and also free from hand stain. The curvette is place in the calibrated turbidity meter and the reading of the turbidity in NTU, on the display is recorded

RESULT DATE 5-01-2000

Turbidity = 26.0 NTU

On 6-01-2000 Turbidity = 26.0

RAINING SEASON 7/8/2000

Turbidity = 29.6 - First treatment plant

Turbidity = 26.4 - Second treatment plant

ON 21ST - AUGUST 2000

Turbidity = 28.5 - First treatment plant

Turbidity = 28 - Second treatment plant

The same procedure has been followed to record PH, Temperature and Turbidity of the Aerated water, Clarify water, Filtered water and the treated water, as may be seen in the table. However it may be Geen that turbidity has an effect on the water due to the rain water droping. Differences in other pqrameters being negligible when considering treatment Cost.

TABLE 3.2 PHYSIO-CHEMICAL PROPERTIES.

DATE: 5TH-JANUARY- 2000 (1st treatment plant)

Quality	**Rw**	**Aw**	**Cw**	**Fw**	**Tw**
Physical Appearances	Unobjectionable				
Turbidity*	26.0	24.5	24.0	26.0	23.0
Temparture (0°)	23.5	25	24.5	23.5	24.4
P H	6.8	6.9	6.9	6.7	6.8
Chlorine Iron(mg/L)	31.28	28.4	26.9	26.9	28.4

Rw = Raw water
Aw = Aerated water
Cw = clarify water
Fw = Filtered water
Tw = Treated water

* Maximum permissible level = 25 (W.H.O. Standard)

TABLE 3.31 PHYSIO- CHEMICAL PROPERTIES OF WATER

1st TREATMENT PLANT

DATE 7-AUGUST- 2000.

Quality Physical	**Rw**	**Aw**	**Cw**	**Fw**	**Tw**
Colour, Odour Taste	Unobjectionable				
Turbidity *	24.5	25.0	24.4	25.0	25.7
Temparture (0^c)	29.6	28.9	16.71	11.1	11.5
P H	6.9	7.1	7.0	7.0	6.9
Chemical Report					
Total Hardness (mg/L)	24	24	22	22	20
Phenolphed Alkalinity (mg/L)	0	0	0	0	0
Methyl Orange Alkali (mg/L)	70	65	65	60	60
Total Alkalinity (mg/L)	70	65	65	60	60
Residual chlorine (mg/L)	-	-	-	-	0.3
Chlorin Iron (mg/L)	49.7	45.4	44.4	41.2	35.5
Total Iron (mg/L)	0.06	0.2	0.06	<0.06	0.06
Total Silical (mg/L)	0	0	0	0.4	5.3
Sulphate (mg/L)	<0.1	<0.1	<0.1	<0.1	<0.1
Nitrate (mg/L)	0.1	0.1	0.0	2	0.2
Manganese (mg/L)	0	0	0	0	<0.078
Nitrogen (mg/L)	<0.078	0	0	0	<0.078
Ammonia (mg/L)	<0.1	-	-	-	<0.1
Dissolved Oxygen (mg/L)	5.46	6.6	6.8	6.7	6.8

SOURCE: FCT WATER BOARD

* Maximum permissible level = 25 (W.H.O standard)

TABLE 3.32 PHYSIO-CHEMICAL PROPERTIES OF WATER

FOR SECOND TREATMENT PLANT

DATE 7-AUGUST- 2000.

Quality Physical	Rw	Aw	Cw	Fw	Tw
Colour, Odour. Taste.	Unobjectionable				
Turbidity*	26.4	30.4	18.6	12.5	0.9
Temparture (0^c)	25.4	25.2	25.	25.2	25.0
P H	6.8	6.9	7.0	7.0	8.6
Chemical Properties					
Total Hardness (Mg/L)	26	24	24	22	22
Phenolphed Alkalinity(Mg/L)	0	0	0	0	20
Methyl Orange Alkali(Mg/L)	70	70	65	60	60
Total Alkalinity (Mg/L)	70	70	65	60	60
Residual chlorine (Mg/L)	0	0	0.4	0.4	0.8
Chlorin Iron (Mg/L)	49.7	42.6	39.1	39.1	35.5
Total Iron (Mg/L)	0.06	0.06	0.06	<0.06	<0.06
Total Silical (Mg/L)	0	0	0	0	5.3
Sulphate (Mg/L)	<0.1	0.1	0.0	2	0.2
Nitrate (Mg/L)	0.1	0.1	0.0	2	0.2
Manganese (Mg/L)	0	0	0	0	<0.078
Nitrogen (Mg/L)	<0.078	<0.078	<0.078	<0.078	<0.078
Ammonia (Mg/L)	<0.1	<0.1	<0.01	<0.1	<0.1
Dissolved Oxygen (Mg/L)	3.4	6.1	6.4	6.7	7.1

SOURCES: FCT WATER BOARD.

* Maximum permissible level = 25 (W.H.O standard)

3.9.5 FLOW RATE

This is the rate at which the raw water from the Usuma Dam gets to the treatment plant. This is not always constant, it varies hourly thereby maintaining the design capacity of the dam. In other words it should never exceed the maximum capacity of the dam. Meanwhile as at the time of conducting this research only the flow rate meter of the first treatment plant is working, at a flowrate of between $4600m^3/hr$, $4400m^3/hr$ and $4200m^3/hr$. The second treatment plant is not operating in full capacity due to some pipes that are yet to be connected. However it discharges about $2600m^3/hr$.

When the second treatment plant is in full operations there would be a total discharge of $10,000m^3/hr$ (i.e240,000m^3/day). the next chapter would determine whether or not this volume will serve the territory.

3.9.6 DOSAGE

This refer to the quantity of substances or chemical to be used in water treatment (i.e Aluminium Sulphate, lime or soda and chlorine). It can be determine during the laboratory examinations or analysis. The essential purpose of this analysis is to determine raw water quality response to purification and possible changes during distribution and the usefulness in house hold and industries. And also to find the correct composition of the concentration.

3.9.7 DOSAGE FOR ALUMINIUM SULPHATE (ALUM)

The capacity of the Alum Tank in the Alum Room, at the dam is $53m^3$/day. Sometimes it may be used for 2 days. Also in the same room is lime. (soda) Tank with a capacity of about 20m3/day several bags of Alum are emptied and dissolve with water and transport to the mixing chamber.

However the dosage of Alum used in treatment plant at lower usuma dam is: 15% of 3067 litres/hr is dose in to water of flow rate of 4500m3/hr with con- cartration of 100g/lit.

while that of lime is 15% of 2025 litre/hr - 4500m3/hr with concertration of 50g/hr.

However one can find a dose rate using the formula:

$$\text{Dose rate} = \frac{\text{flow rate (m3/hr) x dosage}}{\text{solution strength.}}$$

3.9.8 CHLORINATION (DOSAGE)

Pre-chlorination:- this is the addition of chlorine at starting of treatment after alum and lime dosage. It is meant to kill all micro - organism and bacteria that are harmful to human health. Therefore it is needed in larger quantity.

At lower Usuma treatment plant about 15kg is dosed in to $4500m^3$/hr of water in the first treatment plant.

Converting to PPM (Parts per million) or mg/L yield,

1 kg = 1,000,000 milligram

1 m3 = 1000 litres

= 4500m3 = 4,500,000 litres

$$PPM = \frac{1,000,000 \times 15}{4\ 500\ 000} = 3.33 \qquad 4PPM$$

for second treatment plant

$$PPM = \frac{12,000,000}{2,600,000} = 4.6PPM$$

3.9.9**POST CHLORINATION**

This is the addition of chlorine after all the necessary treatment. It is meant to kill any excess bacteria that may be present in the water. It is Usually called DISINFECTION, it is about 4kg and 8kg dosed in to 2600m3 and 3000m3 for first and second treatment plant respectively.

After this post chlorination process, it takes about 30 minutes before the water is pumped to consumers.

CHAPTER FOUR

4.0 WATER DISTRIBUTION IN FCT

Distribution, means transporting the treated water to consumers in several parts of the territory.

There are different ways in which water can be distributed to the consumers. In Abuja FCT water is distributed by gravity. The reservoirs where this water is sourced shouled be constructed above the level of Abuja city so that sufficient pressure can be maintaned.

Meanwhile water from the treatment plant pumped to the elevated storage tank at Kubwa, Karu and Airport with maximum capacity of 12000m^3, 10, 000m^3 and 10,000m^3 respectively. The water serving Karu/ Nyanya takes its source from the tank at Asokoro.

However, with the commissioning of the second treatment plant, the supply in kubwa and Gwagwalada is expected to improve. Kubwa area would be the first to felt the impact with consumers sure of getting 24hours full pressure service. As it now, pipes are being laid to distribute water to Gwagwalada area. Also more water would be allocated to karu and yanya which at present receive their water from water venders when collect their water from public taps.

4.1 WATER REQUIREMENT (CONSUMPTION)

The quantity of water required or consumed per capital varies from place to places. In most developing contries with high population growth and rise in living standard the quantity of water to be produced would depend on the following factors:-

(1) Rate of demand

(2) Design period

(3) Population to be served

The rate of demand is the most important factor. It is expressed in litres/capacity/day that is the amount of water one person can consumed or need in a day. If the population of the area is known then it is multiply by the rate of demand to give the quantity of water required.

4.2 FACTORS AFFECTING RATE OF DEMAND

This varies from places to places

(1) Climatic condition: Water requirement in hot season will be higher than in harmattan. In hot seasons more water would be used for bathing. Watering of gardens, air conditing, parks and fountains. This is normally found in warm countries (like Nigeria).

In cold countries However, Taps are kept open to prevent freezing of pipes. This may therefore in creases consumption rate.

(2) Cost of water: If the cost is high, the consumption would be low and vice-versa.

(3) Habits of people : In many posh cities (like Abuja) the consumption per person is high due rise in living standard. While in some area a common tap will served several family.

(4) Efficiency of water works : Efficiency will effect the consumption leaks in main, unauthorized connection p.t.c it may also effect the losses. This may be reduce by frequent inspeetions.

(5) Metering of services : Provision of meter in the pipe line for water main to the building served, reduces the consumption of water and forces the consumer to use water carefully.

(6) Quality of water : the quality of water effect the rate of demand. This if the water is free from bacteria, odour, colour, the consumption will be high. This is however advantages, because if the water is qualitative some consumers would be willing to pay the high cost for the quality served. But if it has unpleasant odour, the consumption would be low.

FURTHERMORE THE DEMAND FOR WATER CAN BE BASED ON FOLLOWING:

(1) Domestic demand : This is the amount needed for household activities such as Drinking, washing, looking bothing flushing, air condition e.t.c.

According international standard the quantity needed is 200 litres /capita/day.

(2) Commercial needs includes shopping centries, hotels cinema, institutional demands, schools, offices & hostels the following table however gives the standard of consumption per capita per day.

(3) Public Need:- For washing of streets, flushing of sewers, parks e.t.c. Normally 28 lit/capita/day is adopted

(4) Fire demands - For most population the formular below is used for fire demands.

$= 100\ \sqrt{100kL}$ per day

= 100 x 10 x kilo litre per day

= 100x10x1000 litre /day

As at year 2000 Abuja FCT has an estimated population of 481400

:- Fire demands $= \frac{100x10x1000}{481400}$ = 2.07 lit &/capita/day

(7) Losses and wastage's : This due to unauthorized connection, leaks in mains, meter and pump slipage. It is between 20-30%

In Summary, The rate of consumption of a given sity would be estimated as follows:

Domestic need = 200 lit/capita/day

Commercial need = 1000 lit/capita/day

Public need = 25 lit /capita/day

Fire demand = 2 lit /capita/day

Losses = 55 lit/capita/day

1282 litres /capita/day maximum or $1.2m^3$/day

However the full details analysis of Abuja water demand is geyan the scope of write-up.

4.3 POPULATION

ABUJA FCT may be appropriately be described as almost entirely rural. By 1981 no settlement could be described as town then, since none had a population any where neaver to 5,000 not to talk of 20,000. The only settlement approaching this were karu, Abuji and Gwagwalada with population of 4,215, 3,360 and 2,395 respectively.

Today the Federal capital city aloner may be desenbed as Urbam since it has more than 20,000. Other touns close to this figures are kwali, Bwari, Rubochi, karshi, kuje Gwagwa and karimo.

The Table below shows the population Abuja and the four area council.

TABLE 4.3 ABUJA (FCT) POPULATION

Area Council	Population					
	1981	1991	1999	2000	2001	2002
Abaji	18,545	23647	26486	27305	28147	29010
Municipal	72900	212,854	285135	293949	30317	312311
Gwagawlada	39865	80,841	99639	102719	105887	109135
Kuje	39265	61,329	55706	57428	59199	61015
Total	170,575	378,671	46,6966	481,400	496,250	558,870

Source: National population commission.

4.4 ANALYSIS AND FORECASTING

With the population shown above, we can easily deduce the rate of water demand in Abuja as at today. From the population census conducted in 1991, Abuja FCT has 378,671 populace. It was however forecasted that in 2000 the population would be 481 400.

About 250,000 populace consume the 10,000m3/hr supplied from lower Usuma Dam (i.e including the second treatment plant).

If Q = quantity supplied

P = population served

Then the rate at which water is consumed per capital/day

$$= \frac{240,000}{250,000} = 0.96\text{m3 /capita/day}$$

= 960 litres /capita/day

Rate of demand as at Today

$= \frac{240,000}{481400} = 0.499$ m3 /capita/day

or 499 litres /capita

Considering the rise in living standard in Abuja as a federal capital territory, and the rate at which building were constructed, watering of lawns and garden, domestic and other public needs, this wouldn't serve the population even when compare with the international standards.

Assuming a total demand of 1282 litres /capita/day therefore the quantity of water requiring as at today,

Ie; Quantity required = population x rate of demand

= 1.282 m^3/capita/day x 481 400.

= 617,155m^3/day

or 25,715m^3/hr

Year 2001

Quantity required = 1.282 x 496 250

=> 636 193m^3/day

=> or 26,508m^3/hr

<u>Year 2002</u>

Quantity required = 1.282 x 511471

=> 655706m^3/day

=> or 27,321m^3/hr.

Year 2005

Quantity required = 1.282 x 558870

=> 716 472m^3/day

=> or 29853   30,000 m^3/hr

Year 2010

Quantity required = 1.82 x 646 750

=> 829 134 m^3/day

=> 35,000m^3/hr

However One can forecaste future population of a city or country using either

(1) Arithmetic mean

(2) Geometrical mean

(1) Arithmetic mean is given by pn = p + rid

where pn = future population

p = population of year

n = number of decades or year

d = increase in population

(2) The Geometrical mean

$pn = p\ (1+r)^n$

where r = rate of growth per decade or year Geometrical mean is similar to compound interest formula a = p (1+i)n where i = increase in number. This method is useful for cities with unlimited scope for expansion and where constant rate of growth is anticipated.

CHAPTER FIVE

5.0 OPERATION AND MAINTENANCE CULTURE.

The responsibility for delivering safe potable water to the consumers lies on water suppliers management and the operators. To achieve this aim, operation and maintenance of the system facilities most be taken very conscientiously. Operation and maintenance woud keep the system operating smoothly and will extend the useful life span of the facilities.

However, the key component of distribution net-work maintenance are enumerated below:

(1) System Maintaining

(2) Water quality monitoring

(3) Pumps

(4) Water mains

(5) Public relation

5.1 SYSTEM MONITORING

This is carried out to :-

(a) Detect and correct any significant deterioration of facilities of equipment used for the storage and transportation of water.

(b) To detect and correct any problem noticed as sanitary hazard.

For this reasons, the following storage facilities should be check.

- Trespassing (ie Vandalism dumping of trash)
- Security of access to reservoirs
- Roof damage, fence and screen openings
- Weekly inspection to note algae, slime or worm
- Meter readers should be alert for any problem noted during their routine rounds

5.2 **WATER QUALITY**

This is necessary in order to :-

- Establish the safety and portability of the water by ensuring that it meets standards
- Assist in determing the source of any contamination which might have reached the system.
- Detect any changes in quality between source and consumption points.

5.3 **PUMPS**

A comprehensive preventive maintenance program is necessary for all pump installations.

Among the procedures for inspection and preventive maintenance of pumps are as follows

- Observe and record pump pressures and out put as well as the pumps current demands
- Check excessive or abnormal noise, vibration and odour
- Provide grease and oil lubrication in a accordance with the manufacturer's specifications
- Check bearing temperatures once a month with thermometre, if running check for lubricant
- Listen for any bearing noise

- Inspect pump pruning system
- Routinely operate pumps and generators on standby for 15 minutes once a week
- Check pump alignment periodically

5.4 WATER MAINS

Basically, pipes deteriorate on the inside because of water corrosion and erosion and on the outside because of the corrosion from aggressive soil moisture pipe maintenance, is necessary in order to achieve:-

- prevent leakage
- maintain or restore crying capacity
- maintain proper water quality condition
- prolong useful life of the pipe

5.5 VALVES

Inspection of valves include the following routine

- Verify the accuracy of the location of the value boxes on the network map
- Remove the valve box cover
- Closed the valve fully
- Re-open the valve to re-establish flow
- Replace the valve box after cleaning the sets.

5.6 WATER METERS

Maintenance schedule include:-

- Meter use
- Water quality (corrosive, abrasive water
- Age of meter
- Lost of testing and revenue loss

5.7 DISCUSSING AND IMPLICATION OF THE RESULTS

The design capacity of lower usuma dam stand at 100 million cubic meters. It is located within the higher altitude areas of the territory and is sited on a virgin location where there is no human activity (such as farming) thereby ensuring non pollution of the environment and free from industrial environment.

The pH, Temperature and turbidity test carried out during both dry season and raining season however implies that no any source of pollution around the area.

The pH of the raw water and that of treated water (TW) are comparable. This has however complies with WHO international standard and fulfill one of the aim of carrying out this research.

As at 1991 the population of the territory stand at 378671 of which water is supplied to only 250,000 populace.

The remaining possibly believed to be living at the satellites town have to collect their water from water vendors. As at now the population estimated to about 481400 people indicate that more people would still not enjoy full 24 hour service despite the commissioning of additional treatment plant.

The quantity of water required if a 24 hour service has to be adopted from now to year 2010 would be from 30,000 m3/hr to 40,000m^3/hr. In order to meet the set-out objectives of providing adequate potable water supply in adequate quantity the following has to be provided.

1. Good quality control through laboratory test.
2. Construction of additional treatment plant having a design capacity of 40,000m^3/hr.

CHAPTER SIX

6.1 CONCLUSION

In conclusion, the quality of water supplied in Abuja FCT is adequate, with PH of the treated water range from 7 - 7.5 and Turbidity of between 0.5 and 0.8 at moderate temperature of about 25^0c. The supply is 10,000 M^3/hr and the quantity required as at today is about 25,000 M^3/hr which is inadequate.

It was also estimated that by 2010, the demand would be about 35,000 M^3/hr due to rapid increase In population growth.

There is, therefore the need for Government to Invest substantial amount in the provision of adequate quantity of water so as to keep up with growth in demand as a result of population growth and rise in living standard.

6.2 RECOMMENDATION

In order to alleviate entirely the shortage of water in Abuja FCT, and to also prevent water borne disease that causes sickness and claims life of many people, Three (3) sectors, have a key role to play; They are

1. Government
2. Water suppliers management (FCT water Board)
3. The public (consumers).

6.3 WATER SUPPLIER'S(FCT WATER BOARD) MANAGEMENT

1. In trying to maintain the objective of providing an un interrupted service at lower cost, the board has the responsibility of adopting operation and distribution network maintenance of the facilities discussed earlier.
2. In addition, the board has to employ more dedicated staff especially at the water producing department (treatment plant) to allow for shift
3. To provide incentives or allowances to staff

6.4 GOVERNMENT

In the provision of adequate water supply, Government has the major role to play. Large amount of money is required in supply and sanitation coverage of which the government of most developing. African countries cannot afford.

However, In order to actualize our dream of water-for-all in the next years, government should be able to:-

1. Take imitative available increased in funding the sector for accelerated water supply, through Invitation of stakeholders such as UNICEF WORLD BANK, UNDP etc. To donate their aid towards water development programmes.

2. To assign a minimum of 20% of her budgetary allocations to the sector.

3. To make power available, reliable and affordable to water sector.

4. To provide a board of policy makers.

5. To give greater attention to the selections and protection of water sources thereby Improving water quality to places where little or no treatment is required.

6.5 PUBLIC CONSUMERS

On their part, consumers have a role to play in Managing the small quantity pumped to them, as well as contributing their quota to the possibility of providing sufficient quantity.

The following points are of importants:-

(1) To keep taps running, the consumers should pay thier Bills promptly. This would help to generate revenue thereby making the board self-sufficient.

(2) Destruction of pipes by contractors through construction of building and infrastructures, on water lines, should however be stopped.

(3) Consumers should turn their taps off when not in use.

(4) They shou;d consider facilities as their private properties by protecting and reporting pipe burst.

(5) Misuse of facilities provided in the rural areas should also be avoided.

(6) Do not water your plants (Lawn) at odd periods of the day. Water your lawn in the early morning when the whether is cool and windless, watering in the afternoon however, increase evaporation and in the evening it ecourages fungus growth.

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APPENDIX I

STANDARD FOR PHYSICAL AND CHEMICAL QUALITY OF DRINKING WATER W
RECOMMENDED STANDARD

QUALITY	HIGHEST DESIRABLE LEVEL	MAXIMUM PERMISSIBLE LEVE
Physical Turbidity	5 4	25
Colour(on platinum abalt scale)	5 Hazen 1	50Hazen 20
Taste and colour	Unobjectunable	
Chemical	12	25
PH	70 - 8.5 6.5 - 8.5	6.5 - 9.2 9.5
Dissolved solids	500mgll	1500mgll
Suspend solids	500mgll	-
Total hardness	100mgll as $CaCO_3$	500mgll as Ca
Calcium	75mgll	200mgll
Magnisum	150mgll	1500mgll
Iron	0.05mgll	1.5mgll
Manganese	0.1mgll	1.0mgll
Copper	0.05mgll	1.5mgl
Zinc	5.0mgll	15.0m
Chloridi	200mgll	600m
Sulphate	200mgll	400 gll
Phenolic Substance as phonol	0.001mgll	0.1
Cyanidi	0.05mgll	0
Bicarbonate	500mgll	gll
Lead	0.1mgll	
Sodium	-	
Potassium	-	mgll
Anion Detergents	0.2mgll	3mgll
Mineral Oils	0.01mgll	

EVALUATION OF ABUJA WATER SUPPLY

BY

Nasir Abdullahi Illo

(PGD/AGRIC/98/99/65)

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