A SURVEY OF THE POLLUTANT LOAD OF KADUNA INDUSTRIAL DISCHARGES

BY

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DECLARATION

I declare that this thesis is my own work and has not been submitted in any form for another degree or diploma at any other university or institution. Information derived from the published or unpublished work of others has been acknowledged in this text.

Signed _____

Date _____

DEDICATION

This work is exclusively dedicated to Sussie my Wife.

ACKNOWLEDGEMENT

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Special thanks go to my wife Sussie, her friends Comfort and Mbavihin, my Mum and Dad brothers and Sisters Kwenbe Abaagu, Tyosula Ikima, Ejima, Dr. and Mrs. Ityonzughul Teddy Mku, Tony Chianson, Victor Nongu, Emma Kusugh, Tersoo Ivase, Iorfa Aba, Rev. Doo, Ashiekaa John. The clubs, Mr. and Mrs. Nick Audu and all others who have been with me physically or in spirit all along.

ABSTRACT

Temperature, pH, conductivity, suspended solids (SS), chemical oxygen demand (COD), ammonia-nitrogen, phenols, oils and grease chromium, zinc, lead and copper were monitored on discharges from industries in Kaduna. Attention was focussed on those that drain into Kaduna river.

Results show that the following industries or group of industries give discharges with some parameters above permissible limits given by trade effluents standards. Superphosphage Fertilizer Co (Co (pH values below 3) Peugeout Industries (high metal values) Textile Industries (high values for all parameters except ammonia-nitrogen.) COD and SS are higher than permissible limits for all industries monitored especially in relationship to the different end uses of river water put to use. The present position of things in the discharge drains seems a nuisance if it should enter the Kaduna river unchecked. Ways of checking these pollutants have been discussed especially within these industries before discharges come out. Pretreatment of waste with physical means like filtration, chemical means like oxidation, acid base neutralisation and involvement of special equipment has been recommended.

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ABBREVIATIONS

The following abbreviations have been extensively used in this book.

BOD_5	Biochemical Oxygen demand at five days.
COD	Chemical oxygen demand, pH.
Temp.	Temperature.
S.S.	Suspended solids.
Cu	Copper.
Cr	Chromium.
Zn	Zinc.
Pb	Lead.
UNTL	United Nigeria Textiles Limited.
NNTL	Northern Nigeria Textiles Limited.
KTL	Kaduna Textiles Limited.
ATL	Arewa Textiles Limited.
TAP	Turners Absestors Products.
CH.O.D.	Changi Changi Oil Depot.
A.B.C.	Arewa Bottlers Company.
FSFC	Federal Superphosphate Fertilizer Company.
IBBI	International Beer and Beaverage Industries.

EC	Electrical Counductivity.
PAN	Peugeout Automobiles of Nigeria.
MISC	Miscellanueous.
NNPC	Nigeria National Petroleum Corporation Refinery.
NGFM	Nigeria Grains and Flour Mills.
PVC Ltd.	PVC Pipes Nigeria Ltd.

CHAPTER I

INTRODUCTION

1.1 POLLUTION IN GENERAL

The word pollution means a condition of being unclean or filthy. Lately the issue of pollution has suddenly become a matter of attention, mainly because of the rate at which it is growing. The incedence of pollution has being with us for a long time and its consequences too. In 1947 andunsual and painful disease of a rheumatic nature was recorded in case of 44 patients from a Japanese village. During the subsequent years it was known as "itai-itai" (meaning "Ouch-Ouch") in accordance with the patients shrieks resulting from painful skeletal deformities.

The cause of this desease was completely unknown until 1961 when sufficient evidence led to the postulation that cadmium played a role in the skeletal developments. Based on the findings of further Government Supported studies, the Japanese Ministry of Health and Welfare declared in 1968 "the itai-itai disease is caused by chronic Cadmium poisoning.[2]

In 1953 there was an outbreak of mysterious, non infectional neurologic illness amongst inhabitants of Minamata who are mainly fisherfolk.

A patient who consumed fish and shell fish from that region progressive-

ly suffered from weakening of muscles, loss of vision, impairement of cerebral functions and eventual paralysis which in normal cases resulted into coma and death. This disease became known as the Minamata disease and after extensive investigations it was revealed in 1959 that the deaths were caused by the consumption of fish and other foodstuffs conterminated with methylmercury. The source of methylmercury contermination was traced to effluents from various plants of the chemical firm Chisso Co. manufactures of plastics (PVC).[3]

There are numerous literature on accidents due to presence of pollutants both in water and on land. In Nigeria these things are present and happening but very little research or attention is given to it. Streets and gutters and dumps are full of domestic wates, old vehicles and heaps of material of no fixed description, people living by streams, drains and river banks do not find any better dumping place than these places, causing congestion in them.

Direct use of river water for drinking and other purposes occurs mainly in the rural areas but not likely in the metropolis. However, in some cases, the largest proportion of the population live in rural areas and often rely on this supply. Since it is inconceivable and unrealistic to treat the whole of Kaduna river water, it is necessary to prevent its pollution by possible diversion of pollutants from the source to elsewhere or treatment before allowwing the water to reach the river.

1.2 INDUSTRIAL POLLUTION

Heavy metal pollution has been reported in respect of Chromium VI which was contained in untreated slimes and factory wastes deposited by the largest consumer of chromium in Japan, the Nippon chemical industrial company. Conservative estimates have it that 530,000 tons of reduced slimes and wastes containing hexavalent chromium were dumped around Tokyo and in the neighbouring Chika.

Due to its hardening properties, this waste material has gained extensive use for constructional purposes such as fortification of reclaimed land, building sites, schools and recreational ground.

Already in 1960 fatal accidents of lung cancer were reported from Kiryama factory of the Nippon-Denko concern on the island of Hokkaido. Medical warnings were issued that exposure by inhalation of dust containing chromium in high oxidation states (IV and VI) was associated with malignant growth in the respiratory tract and painless perforation of the nasal septum. No particular action was however taken but in August 1985 it was found that drinking water in Tokyo obtained from ground water near the chromium containing spoil heaps contained more than 200 times the official threshold limit of chromium. The authorities are now trying to cover this precarious situation.[6]

A close look at the contents of industrial waste waters within various industries in Kaduna will show what is likely to reach the river if untreated. The Federal Super Phosphate Fertilizer Company produces sulphuric acid and this

gets into its waste waters and into the drain in the event of spillages. The steeping operations, the fermentation, the yiest recovery and wash waters make up waste water from Nigeria Brewery Ltd. while high grease loading, dissolved solides, fibrous material and spent scour (a mixture of alkaline agent, water and detergent) solutions are contents of textile waste waters.

Changi Changi Oil Depot mainly does the washing of petroleum products tanks and discharge of the washings into the Makera drain. Peugeot Automobiles of Nigeria discharge waste water mainly containing paints with heavy metals especially lead and zinc while the Petroleum refinery activities produce waste water with waste biosludge coke fines, silt from storm water run off which contain oil, water, sand and silt heavy metals phenols and cyanide.

1.3 SITUATION IN KADUNA

In Kaduna the Project site, only few of the refuse disposal facilities build for the purpose are actually utilized. Municipal and industrial effluents are channelled into the same drains and subesequently into the river irrespective of their quality. Generally, the sorrounding present horrific site and foul ordours when one moves around especially in the industrial area of Kakuri and Makera. This is as a result if indiscriminate litering of excreta mixed with domestic and industrial effluents.

Introduction of excessive quantities of waste material in natural waters can upset the balance which exists between plants and animals with considerable interraction among life forms. This will not only create congestion, but also

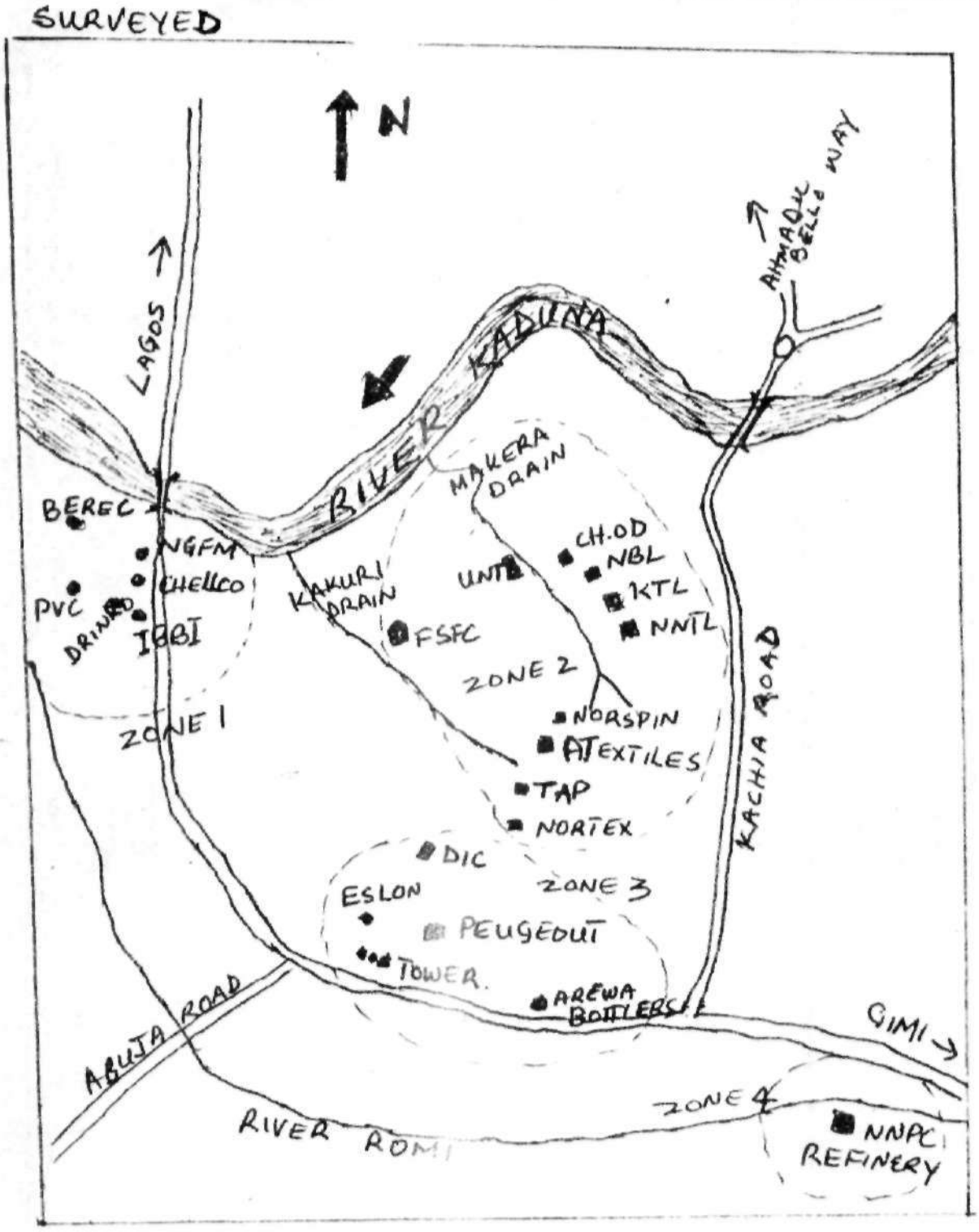
result into depletion of oxygen in the water. There are five major end uses of river water: fishing, navigation, recreation, irrigation and drinking. For Kaduna river, subsistence fishing is the only type of fishing to be considered compared to game and commercial fishing. The main parameters that affect fish catch are dissolved oxygen concentration, presence of toxic compounds such as cyanide and heavy metals, the presence of biodegradable substances which are concentrated in the food chain (such as DDT) and substances which impart an undesirable odour and taste to fish.

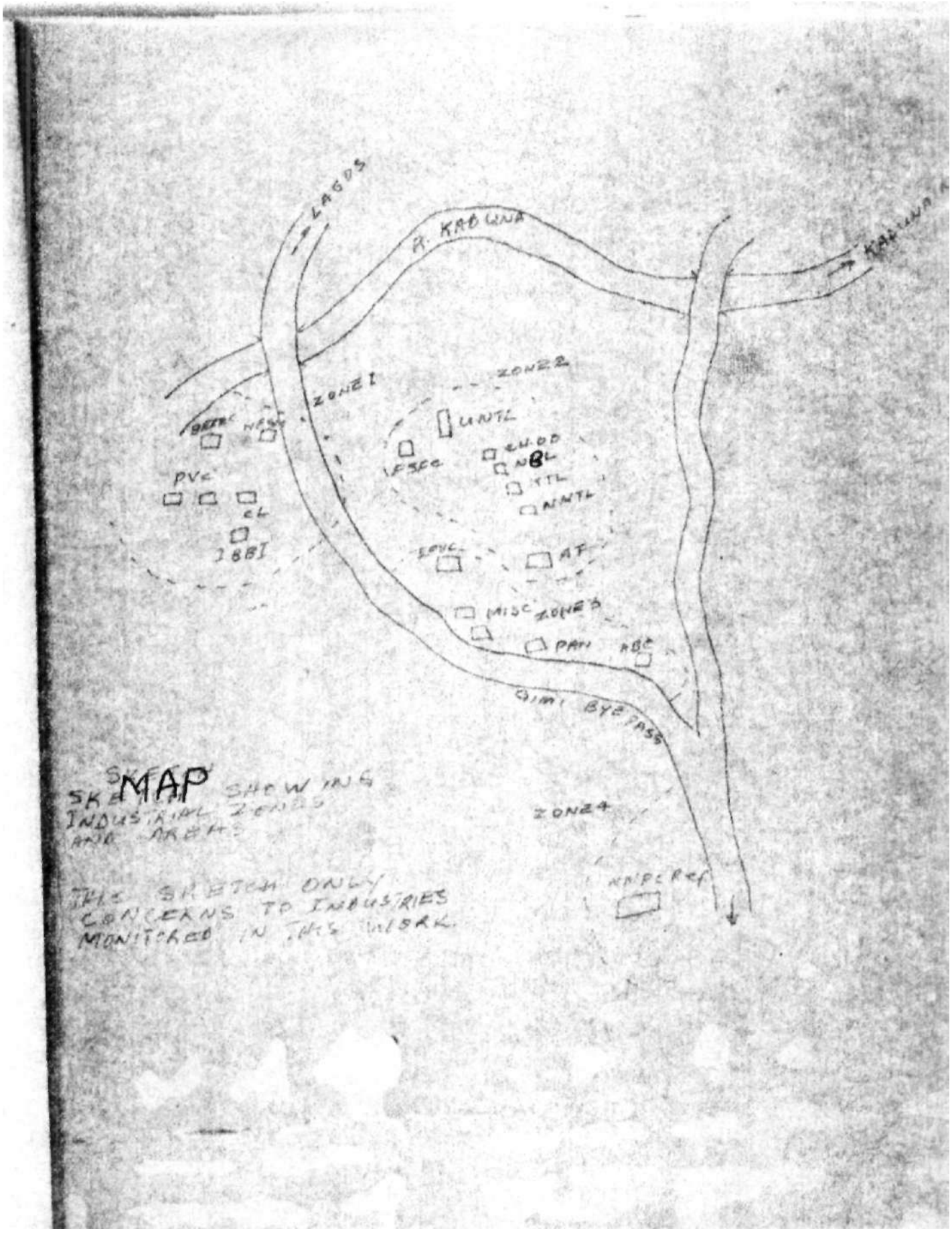
Table A: Showing various end uses of water

Domestic	Agricultural	Industrial	Transport	Recreation
Drinking Cooking Washing Gardening Bathing	Fishing Fish Culture Irrigation	Cooling Process Water	Shipping	Botling

Little published work is available on tropical fish toxicity or the effect of pollutants on tropical stream ecology but many examples of reduction in fish catches over the years of pollution built up have been cited by fishermen. Navigation on Kaduna river is only possible during its flooded period June to September and only small crafts are used, mainly wooden canoes. These do not raise quality problems in the water. Recreational uses of surface water resource such as swimming, boating and water skiing are less justifiable reasons for controlling water pollution in developing countries

MAP OF KADUNA INDUSTRIAL AREAS AND ZONES SURVEYED




LAGOS
R. KADUNA
KADUNA
ZONE 1
ZONE 2
UNTL
IFSEC
EN.OD
NBL
TTL
NNTL
PVC
CL
IBBI
LOVC
AT
MISC
ZONE 3
PAH
ABC
OJIMI BYE PASS
ZONE 4
KNPLRF
SKETCH MAP SHOWING INDUSTRIAL ZONES AND AREAS
THIS SKETCH ONLY CONCERNS TO INDUSTRIES MONITORED IN THIS WORK.

than in developed ones. People generally have much less time for recreation and little money to spend on it. Irrigation accounts for the largest water use in tropical developing countries and may sometimes be the only basis for stream standards where quantities are inadequate for crop production or where there are saline or poorly drained soils. Municipal sewage does not contribute much towards salinity on discharge to a river, but industrial waste and irrigation return waters can increase salinity to a significant level.[5]

1.4 AIMS AND OBJECTIVES

The aims and objectives of this work are:-

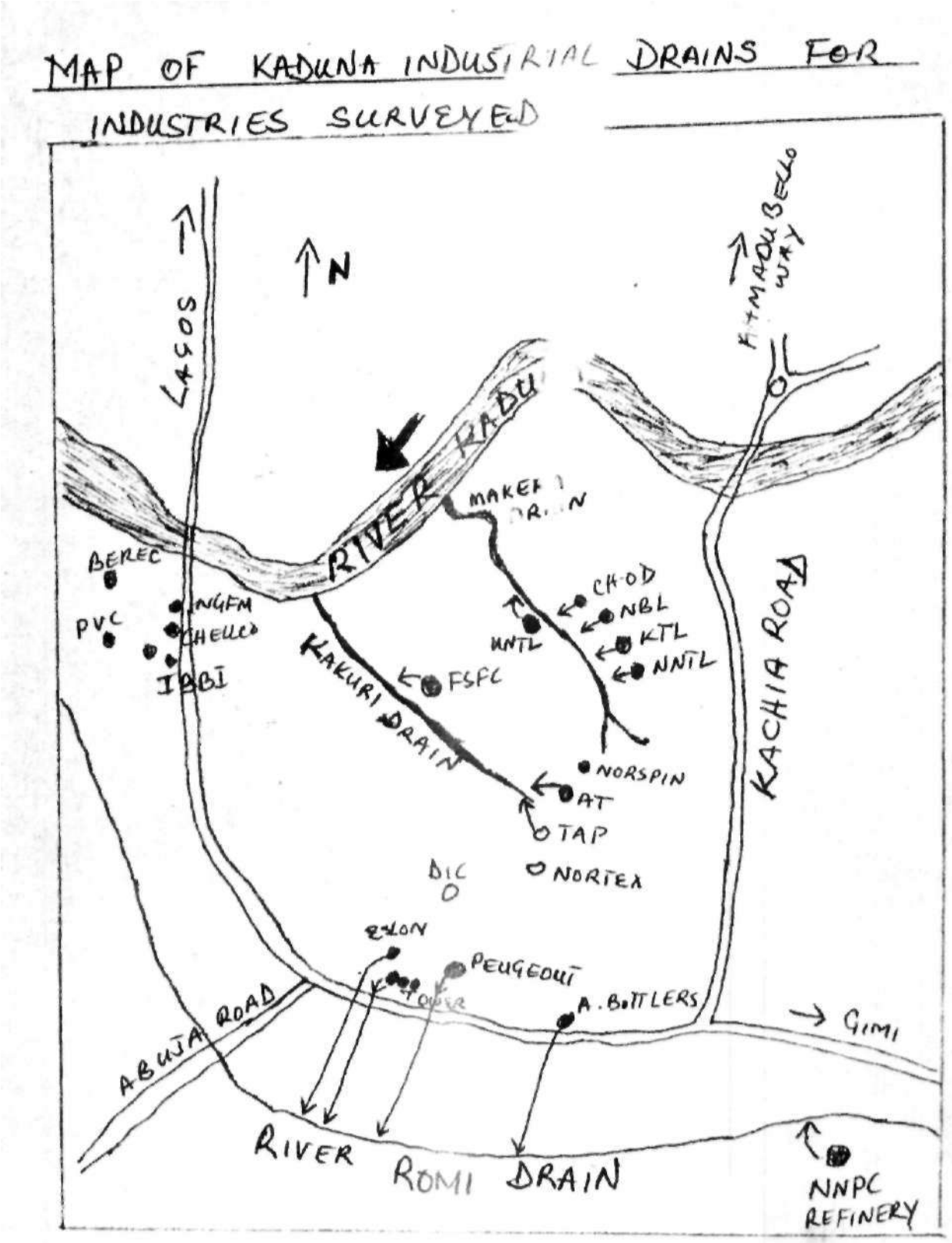
1. To locate the various industries in Kaduna, get acquainted with their processes and their products.

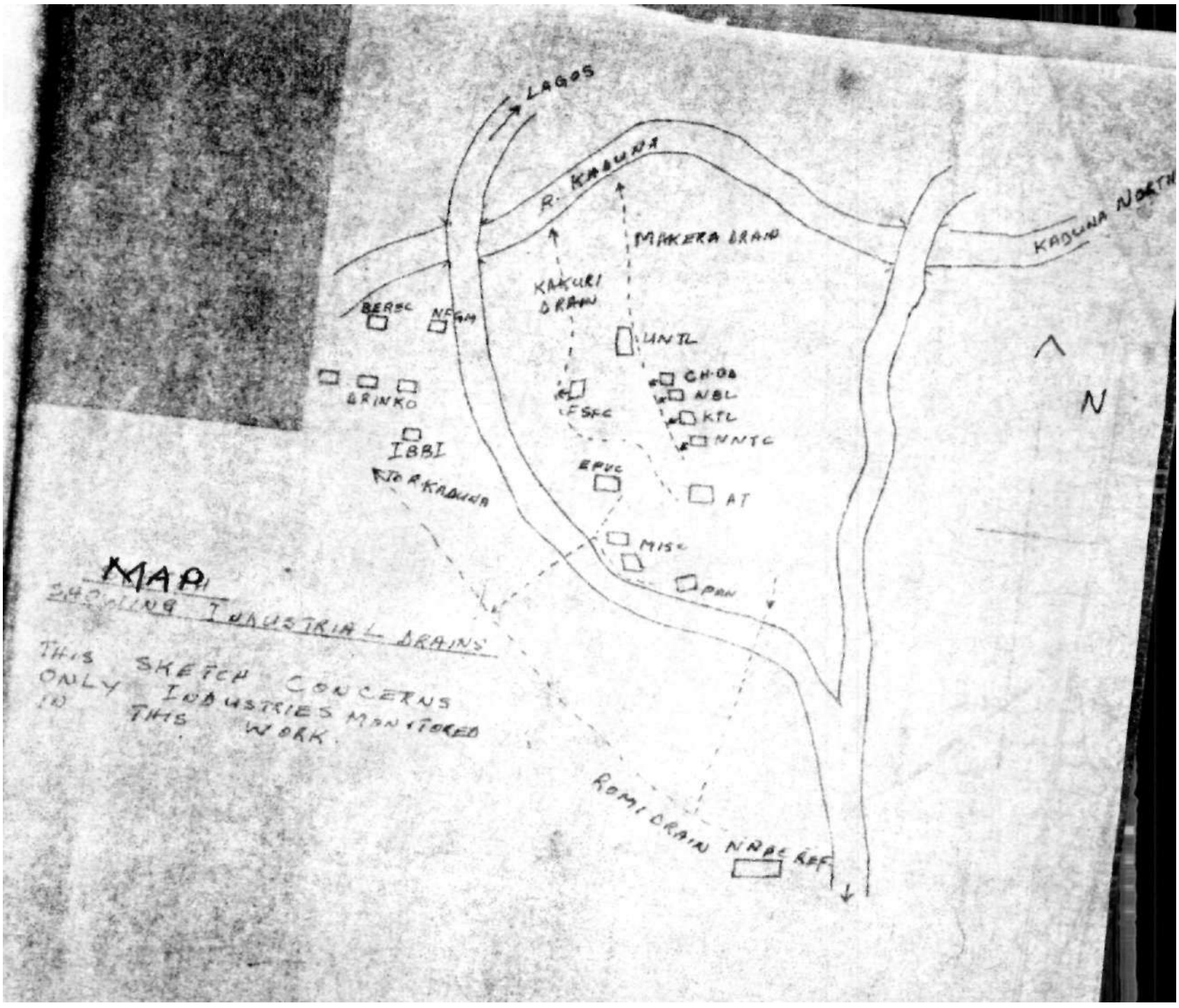
2. To be able to assess the effluents coming out of these industries with respect to certain parameters.

3. With respect to (2) be able to say which industries or group of industries contribute a greatest load of pollutants that enter the Kaduna river.

4. To supply data and information that will enable standards to be set and regulations to guide against future pollutional consequences.

MAP OF KADUNA INDUSTRIAL DRAINS FOR INDUSTRIES SURVEYED




LAGOS
R. KADUNA
MAKERA DRAIN
KADUNA NORTH
KAKURI DRAIN
BERSC
NFGM
UNTL
CH-GL
NBL
KTL
NNTC
FSHC
BRINKO
IBBI
TO KADUNA
EPUC
AT
MISC
PRN
N
MAP
SHOWING INDUSTRIAL DRAINS
THIS SKETCH CONCERNS ONLY INDUSTRIES MONITORED IN THIS WORK.
ROMI DRAIN
NNBL REF

CHAPTER II

INDUSTRIAL SURVEY AND PARAMETERS MONITORED

2.1 SURVEY OF INDUSTRIES

A survey of industrial setups in Kaduna area was made as an initial step of this work. There are four major zones of industrial setups. The first zone is the area adjacent to Nassarawa village along the Gimi byepass very near the byepass bridge along the Kaduna river. This zone contains the International Beer and Beverages Industries (I.B.B.I.), Chelko, (CL) Nigeria Grains and Flour Mills (N.G.F.M.), Drinko (makers of Brahma) PVC pipes Nig. Ltd. and Berec. The second zone is made up of the old industrial area of Kakuri and Makera wards. The Arewa Textiles, FSFC, NNTL, KTL, NBL, UNTL, TAP are found in this group. The third zone is situated on the Gimi byepass near the Abuja junction and here is found the Peugeout Industries, Tower industries (collectively called miscellaneous industries in this work), the Eslon PVC pipes, and Arewa Bottlers (Makers of pepsi cola). The fourth zone is situated well out of Kaduna town and only the NNPC refinery belongs to this zone along Gimi road. Apart from industrial zones, industries were grouped according to their drains which lead finally to Kaduna river.

There are three major drains taking effluents from these industries.

The river Romi, the Makera drain, the Kakuri drains. Table B shows the various drains and industries discharging into them. The Nortex and Norspin textile mills are not in production while I.B.B.I. PVC pipes of Nigeria Ltd. are yet to take off.

The survey also revealed the raw materials, the processes and the products obtained in these industries which are put in Table C.

Table B: Drains taking discharges from Industries

1.	River Romi drain
	NNPC Refinery
	Arewa Bottlers Company
	Peugeout Automobile Ltd.
	Eslon PVC Pipes Ltd.
	Miscellaneous Industries
	IBBI, Drinko, PVC Pipes Nig. Ltd.
	(not certain where they drain).
2.	Kakuri drain
	Turners Asbestos Products
	Arewa Textiles
	Federal Superphosphate Fertilizer Company.
3.	Makera drain
	United Nigeria Textile Ltd.
	Northern Nigeria Textile Ltd.
	Kaduna Textile Ltd.
	Changi Changi Oil Depot
	Nigeria Brewery Ltd.

TABLE C

No.	Name of Factory	Type of raw material used/ production figures	Types of goods/ production figures
1	Area Textiles	Acetic acid; 10 t/m caustic soda; 10 t/m Na_2CO_3 K_2CO_3 5 t/m H_2SO_4; 20 t/m solvents 15 t/m detergents 30 t/m dyes.	70,000.000 m/a printed cloth.
2	Unit Nig. Textiles	9,100.000 kg/a cotton; data on raw dyesult; 1 t/d caustic soda; 0,8 t/d soda ash; 1,5 t sodium bicarbonat; 100 kg/d sulfuric acid; 2 t/d Titanic Acid citric acid; 1,5 t/d hydrogen peroxide.	
3	Kaduna Textiles	Data on raw material used not available.	54,600.00 m/a printed cloth. 2,700.000 m/a polypropylen cloth.
4	Norspin Textiles	Caustic soda, dyes, ask, hydrogen peroxide (quantities not available).	
5	Northern Nig. Textiles	12,000.000 m/a raw cloth from Kaduna Textile.	8,000.000 m/a finished cloth.
6	J. Surgical Prod.	Caustic soda; H_2SO_4; bleaching powder quantities not available.	
7	Nortex	1,514.300 kg/a cotton.	8,800.00 m/a dyed cloth.
8	Zamfara Textiles	Starches, maize cassava tyres.	
9	Peugeot Automabile		23,800 cars/a
10	Nigerian Breweries	5,000 t/m malt; 7500 kg/a hops 1000 t/a sugar.	400,000 hl/a beer and malt beer.
11	Fed. Superf. Fert.	60,000 t/a phosphor rock; 13,000 t/a sulphoric.	Fertilizer.
12	Defence Ind. Corp.	Hydrochloric acid; nitric acid; sulphuric acid etc. other raw materials confidential.	Production figures confidential.
13	Turners Asbestos	Asbestos fibre, cemented paper, etc.	data not available.

Table D: Parameters Monitored

INDUSTRIAL GROUP	PARAMETERS													INDUSTRY
	BOD	COD	phenol	SS	pH	Cr	Pb	Zn	Cu	Temp	EC	NH_3-N	Oil & Grease	Industry
Textiles		X	X	X	X	X	X	X	X	X	X	X	X	UNTL, NNTL, KTL, Arewa Textile
Food and Drinks		X	X	X	X					X	X	X	X	ABC, NBL DRINKO
Metallic		X	X	X	X	X	X	X	X	X	X	X	X	MISC., PAN
Oil and Refinery		X	X	X	X	X	X	X	X	X	X	X	X	NNPC, CH.O.D.
Chemical		X	X	X	X					X	X	X	X	FSFC, PVC pipes ESLON, FSFC.

2.2 PARAMETERS MONOTIRED

Parameters monitored in this work are Biochemical oxygen demand at $30^{O}C$ (BOD_5) chemical oxygen demand (COD) phenols, suspended solids (SS) pH chromium, lead, zinc, copper, Temperature, Electrical conductivity (EC) Ammonia-Nitrogen and oil and grease. The choice was based on the type of industries surveyed and those parameters that involved instrumentation more than manual analysis. The literature review done on similar works by United Nations development project (1975) the time at my disposal for the whole work and limitations due to shortage of equipment.

2.3 CHEMICAL OXYGEN DEMAND (COD)

This is the amount oxygen consumed or required in non bacterial oxidition of matter by strong oxidants within a short time. The value gives the complete oxidisability of nearly all materials to be expected in dissolved form in residential and industrial waste effluents.[8] The difference between COD and BOD is that in BOD there is degradation of organic matter by bacteria and the amount of oxygen consumed is realized after some few days. In the case of COD the oxidation is rapid and complete within a short time and non bacterial. The two require an amount of dissolved oxygen in the medium. The values of COD are normally higher than BOD because the former incoporates both the chemical and biological reactions involved oxygen used in both bacterial degradation and chemical oxidation is assessed in COD measurement.

This order may not necessarily follow if in a particular medium the bio degradation over five days is very high yet due to certain chemical substances within the same medium the amount of oxygen required (which includes that of chemical and biological oxidation) in COD determination is very low.

2.4 PHENOLS

These are hydroxy aromatic compounds like benzene and derivatives found in decaying leaves, urine, dyes, pesticides domestic and industrial effluents. They can be detected in water by their taste even in concentrations of 0.1 mg/1. This is enhanced when the water is treated with chlorine which results into the formation of chloraphenols which have a strong odour and taste. Phenols

are toxic for most living organisms. For fish they are known to taint their flesh when present in certain threshold concentrations. Apart from toxicity, subletha l quantities beginning from 0.1 mg/1 can render fish inconsummable unless the flavor is restored by maintaining the caught fish in very clean water for a fairly long time.[19]

2.5 SUSPENDED SOLIDS

Suspended solids are made up of non filtrable matter emanating from different sources depending on the processes involved. Suspended solids of industrial nature consists mainly of solid particles which do not only cause turbidity but decrease the amount of dissolved oxygen in water and light penetration.

The suspended solids contents of many tropical rivers have been reported to be quite high as can be seen in these examples.[10]

4000mg/l in Jumuna at Delhi (India)

4000mg/l in the Nile at Cairo (Egypt)

3600mg/l in the Hooghly at Calcutta (India).

2.6 CHROMIUM

This is one of the least-toxic of the trace elements on the basis of its over supply and essentiality. Generally, the mammalian body can tolerate 100-200 times its total body content of chromium without harmful effects chromium VI salts are approximately 100 times more toxic than chromium III salts.

2.7 LEAD

Lead resembles the divalent alkaline earth group metals in chemical reaction.

Metabolism of lead and calcium are similar both in their deposition in and mobilisation from bone, since lead can remain immobilized for years metabolic disturbance can remain undetected. Under normal circumstances more than 90% of lead retained in the body is in the skeleton. One of the most common consequences of long term lead poisoning is chronic kidney infection known as nephritis.

In 1929 a Physician in Australia became aware of high incidence of nephritis and early death in Queensland. Investigation revealed the disease in children who drank rain water collected from roofs protected from lead pigment paint. In 1954 it was subsequently established that out of the 352 adults who had had childhood lead poisoning 15-40 years earlier, 165 had died, 94 of chronic nephritis.[11]

The large affinity of lead ions for thiol and phosphate-containing ligands inhibit the biosynthesis of heme and thereby affects membrane permiability of kidney, liver and brain cells.

This results in either reduced functioning or complete break down of these tissues, since lead is a cumulative substance. Though present in affluents of galvanised services it is relatively low in natural waters.

2.8 ZINC

Zinc is one of the most abundant essential trace elements in the human body. It is a constituent of all cells, and several enzymes depend upon it as a cofactor. Its role in metabolic processes is eminent. Quantities in the range of 2-24 mg/l can cause a bitter astrigent-taste and are toxic of plants. In metal and galvanizing industries zinc appears in metallic forms while in others it appears as zinc salts. Zinc may also affect metabolism of humans already suffering from irregular metabolism.[12]

2.9 COPPER

The presence of copper in plant and animal tissues was recognised more than 150 years ago. Long before it was recognized as an essential element in the diet of birds and animals, it was detected as component of blood proteins of snails, it is also an essential element in enzymes.

Excessive in-take of copper results in its accumulating in the liver. A case of serious poisoning of fish off the coast of Holland where many fish of diversified species and sizes died has been recorded. The source of toxi~ fication was discovered accidentaly to be several kilograms of copper sulphate crystals buried under sand in that region. From subsequent analysis it was established that wherever dead fish were encountered the sea water contained a copper concentration of several hundred mg/l.[13]

2.10 pH

pH of a medium is the logarithm to the base 10 of the reciporocal of the hydrogen ion concentration (the hydrogen ion concentration is measured in moles per litre). Solutions of pH zero to seven are dimisishingly acid, seven to fourteen alkaline and seven neutral. The pH of most natural systems especially water lies in the range of 6 to 8.5 the value governed by carbon dioxide, hydrogencarbonate and carbonate equilibrium. Effluents can have pH values much lower or higher depending upon their nature and treatment. The effect of pH on the chemical and biological properties of a liquid makes its determination very important. Knowledge of water pH is useful in determining necessary measures for corrosion control, sanitation and adequate disinfection.

2.11 TEMPERATURE

Temperature is normally expressed in degrees centigrade (^{o}C). It is always taken in accompaniment with other parameters like electrical conductivity and Biochemical Oxygen demand. It is also possible to employ temperature reading in the calculation ofvarious forms of alkalinity and in saturation and stability studies with respect to calcium carbonate. Also due to the relationship between conductivity and temperature most industrial discharges that come out hot (high temperatures) have different values of conductivities from when they are cold especially the textiles.

2.12 ELECTRICAL CONDUCTIVITY

The conductivity of a solution depends on the type and number of ions present in the solution. Electrical conductivity shows the ability of these ions to receive and convey an electric current and it therefore represents the amount of dissolved solids in a particular water sample. Some industrial effluents seem to contain a lot of waste but most of it is suspended and so does not contribute to the electrical conductivity. Such wastes will naturally record low values of this parameter but in essence may be very toxic. This applies especially to metallic industries.

And on the other hand industries with most of their pollutants dissolved will give a high conductivity as seen in the textile and chemical industries.

2.13 AMMONIA NITROGEN

Ammonia is known to be toxic to life because it decreases the oxygen carrying capacity of the blood. If present in water can cause lethal consequences for aquatic life. It is however a non-persistent and non-cumulative substance since it is capable of conversion into nitrates, nitrites and even nitrogen by the natural nitrogen cycle.

CHAPTER III

SAMPLING AND ANALYSIS

3.1 SAMPLING

Due to the varied nature of industrial effluents, instantaneous samples taken may not afford a reliable guide to the nature of the overall discharge.

To ensure the concentrations of the determinands in the samples do not change between sampling and analysis, sampling was done near to the industries as possible, It was carried out at the centre of the flow of the discharge. Vessels used depended on the parameters monitored. The organic parameters were monitored with samples taken in glassware. In the case of inorganic parameters plastic vessels were used. In both cases containers were of between 500 ml to four litre capacity depending on the quantity required. In certain circumstances special samples, were required and these were taken as described under the individual texts. All vessels were washed clean with teepol washing liquid and always rinsed three times with the sample before sampling.

Sampling time was mostly in the morning 9-12 noon and very rarely in the afternoons. The following information was taken on the spot:

(i) Details of type of sample.

(ii) Place and time of sample.

(iii) Temperature of sample.

Some of the samples were taken from outfall of pipe viz. Kaduna Textiles, Federal Superphosphate Fertilizer Company, Arewa Textiles and Eslon PVC pipes, while the rest were flowing in a gutter. Because most of the streams containing effluents were relatively shallow, bottles used in sampling were held with hands (glove covered).

To ensure correct and representative sampling, three sub-samples were taken five meters away from each other and put together to make up a composite sample.

3.2 PRESERVATION

Since it has not been possible to carry out chemical analysis on samples on the spot certain preservative measures had to be adopted as specified in the texts.[14]

Parameters	Preservation Method
BOD	= Kept under 4^{o}C using ice and analysed within 6 hours of sampling.
COD	= 2 ml of concentrated sulphuric acid was added per litr of sample and analysed within 7 days.
PHENOLS	= 1 g of copper sulphate and phosphoric acid was added and maintained at pH4 the temperature kept below 4^{o}C with ice blocks and analysed within 24 hours.
METALS	= 5 ml of nitric acid per litre of sample.
AMMONIA-NITROGEN	= 40 mg of mecurous chloride per litre of sample maintained at below 4^{o}C before analysis.

3.3 PRE-TREATMENT

Due to the varied nature of the samples the incidence of interference of some substances on the monitoring of parameters cannot be ruled out. It has therefore been necessary to pretreat the samples before some analysis.[15]

(i) Metals — Inorder to ensure adequate digestion of all materials 0.5 ml of concentrated sulphuric acid was added to 150 ml of sample filtered or unfiltered depending on whether or not dissolved metal determination was carried out. It was boiled to white fume stage, cooled and 1 ml of 60% perchloric acid, 5 ml of concentrated nitric acid were added.

(ii) BOD — pH of sample was adjusted to between 6.5 and 8.5. The samples were also diluted largely and well shaken to ensure large amounts of dissolved oxygen.

(iii) Phenols — Samples were treated with few drops of ammonium polysulphide solution to convert any cyanide present to thiocyanate. The mixture was allowed to stand for 10 minutes. The sulphides were removed by adding a little excess of lead carbonate. The mixture was filtered into a distillation flask. Amines were removed by adding 10 ml of sodium hydroxide. The distillate

was taken and 10 ml sulphuric acid (dilute) added. The distillate was redistilled and finally collected for the test.

(iv) Ammonia Nitrogen — The sample is distilled with 0.2 mg of light magnesium oxide and sodium hydroxide. The distillate is collected for analysis.

Details of analysis come in the colum of analysis.

3.4 TRANSPORTATION

The sites of sampling apart from being at different places within Kaduna area is situated about 100 kilometers away from place of analysis. Samples had to be taken and transported across this distance each time. A large cooler plastic container with ice blocks was used to store these samples during transportation. The road network is on the average good so the problem of agitation which leads to loss of volatile constituents was minimised.

3.5 INSTRUMENTS USED

Some analysis carried out in this work were instrumental while the rest were manually carried out. Those instruments used are:

Conductivity bridge type Mc EII portable type for conductivity measurement
pH Meter Griffin portable-type B17 DA
Oven, range 30-200^{o}C
Atomic Absorption Spectrophotometer

Pye Unicam SP 1900

U.V. Spectrophotometer

Mettler balance

Thermometers 0-100^{o}C range.

3.6 REAGENTS AND CHEMICALS PREPARED FOR ANALYSIS

Metals[14,15]

Deionised water was used and kept free from all impurities. Reagents used are of analytical reagent grade.

Perchloric acid 60% V/V

Sulphuric acid (36N)

Nitric Acid dilute - mixed one volume of concentrated nitric acid with 2 volumes of water.

Nitric acid (conc.)(16N)

Phosphoric acid - 85% V/V

Potassium Permanganate - 0.1N reagent solution

Sodium azide solution 50g of sodium azide was dissolved in water and made up to one litre.

SYM-Diphenylcarbazide Solution - 0.25g of the salt and 4g of phthalic anhydride were dissolved in 100ml of 95% ethanol.

Ammonium Hydroxide - 1 volume of conc. ammonia solution (18N) were mixed with 9 volumes of water.

Ammonium Citrate Solution 5g of citric acid monohydrate was dissolved in water and 100ml of conc ammoniacal solution (35% m/V) was added. The volume made up to 250ml.

Sodium Diethylthio Carbamate - 0.1% in water.

Dithizone Stock Solution in Chloroform - 1.10g of diphenylthiobazone was dissolved in 100ml of chloroform and storedin a refridgerator.

Dithiozone Working Solution in Water - 6ml of the stock solution was put in a 100 separating flask, 10ml of 0.5N ammonia solution were added and shaken. The chloroform layer was discarded and the remaining chloroform droplets removed by filtration with wet filter paper.

Hydrochloric Acid - (1N)

Hydrochloric Acid - mixed with water in 1:1 ratio

Hydroxyl Ammonium Chloride Solution - A. 1% m/V solution in water

Sodium Hexametaphosphate - 10g of the salt were dissolved in 100ml of water. Traces of lead were removed by extracting with dithizone in chloroform at pH/10 (adjusted with ammonia solution). Traces of dithizone were removed by making just acid and chloroform. The pH was finally adjusted back to 9.5 for maximum stability.

3.6.2 COD

Silver Sulphate Solution: A 1.25% m/V saturated solution in dilute sulphuric acid (conc mixed with equal volume of water).

Iron II Sulphate 0.125N 64.75g of salt ($FeSO_4 7H_2O$) was dissolved in 100ml of dilute sulphuric acid and diluted to one litre.

Potassium Dichromate 6.129g of potassium dichromate was dissolved in water and made up to a litre 0.125N.

Iron (II) - 1.10 - Phenanthroline Indicator Solution 3.475g of Iron II

Sulphate hepta hydrate was dissolved in 500ml of water. 7.427g of 1,10 phenanthroline monohydrate was added and shaken until the mixture dissolved.

3.6.3 Ammonia Nitrogen

Ammonia Free Distilled Water: 2ml of a solution of iron II sulphate (100g per litre of $FeSO\ 4.7H_2O$) and sufficient sulphuric acid was added to each litre of tap water to give a slight acid reaction to methyl orange. The mixture was distilled and first absence or otherwise of ammonia in this distilled water was tested with Nesslers reagent.

Nesslers Reagent 35g of Potassium iodide and 12.5g of mercury II chloride were dissolved in 700ml of water. A saturated solution of Mercury II chloride was added with stirring until a slight permanent red precipitate was formed. 120g of sodium hydroxide was dissolved in 150ml of water and added to the mixture.

The mixture was cooled, 1ml of Mercury II chloride added and diluted to one litre. It was stored in a dark rubber stoppered bottle in the re-fridgerator before and after use.

Ammonia Chloride Stock Solution 3.819g of pure ammonium chloride, dried at $105^{o}C$ was dissolved in ammonia free water and made up to 1 litre with ammonia free water. 1.0ml=10g ammonia as Nitrogen.

Ammonia Chloride Working Solution 10.0ml of the stock solution was diluted to 1 litre with ammonia free water.

1.0ml = 1.0mg ammonia - Nitrogen.

3.6.4 Phenols

Potassium Ferricyanide 8% m/V in solution.

Ammonium Chloride 5% m/V in solution.

Amminoantipyrine (0.1M) 2.033g wa dissolved in 100ml of water.

3.7 ANALYSIS

3.7.1 pH Determination

pH of an effluent can either be determined electrometically or colorimetrically. The electrometric method is most accurate and is relatively free from interferences.[16] The colorimetric indicator can be used only if approximate pH values are required. The former method is used in this project. It involves the measurement of electromotive force (EMF) of a cell comprising an indicator electrode immersed in the test solution, and a reference electrode. Contact between the test solution and the reference electrode is usually by means of a liquid junction which forms part of the reference electrode.

A portable pH meter was used here, both the indicator and reference electrodes are fused into one and the process involves dipping the electrode into the sample.

3.7.2 Electrical Conductivity Determination

Electrical conductivity is measured by a portable MC.3 EIL conductivity meter. The cell which is attached to the bridge was rinsed with distilled water several times as well as with the sample before measurement began. The

selector switch is set to the appropriate range x1, x10, x100 and the key is depressed. The signal is adjusted to the centre and where the arrow of adjustment switch is pointed is the value of the conductivity expressed in umhos.

3.7.3 Suspended Solids Determination

The filtration method is recommended for determination of total suspended solids.[16]

Requirements

Glass fibre filter paper gooch crucible vacuum suction apparatus, evaporating dish, steam bath and weighing metler balance.

Procedure

The glass fibre filter paper was placed in the bottom of gooch crucible and with suction, it was washed with three successive 20ml volumes of distilled water. The washings were discarded. The paper was removed, placed on a watch glass and heated in an oven at 105^{o}C for 1 hour. It was cooled in a dessicator and weighed. The paper was replaced in the funnel assembly and moistened with distilled water. A little but known volume of the sample-well mixed was transferred to the paper and filtered under slight suction ensuring that all solids were transferred to the paper. The residue was washed 3 times with 10ml of distilled water. The paper was carefully removed and placed on a watch glass and dried at 105^{o}C for 1 hour. The paper was removed cooled in a dessicator and weighed to constant weight.

IBRAHIM

Suspended Solid, mg/1 = $\frac{A-B}{C} \times 1000$

A. = Weight of paper plus solids

B. = Weight of paper only

C. = Volume of sample used.

3.7.4 Chemical Oxygen Demand (COD) Determination

The sample is boiled under reflux with potassium dichromate and silver sulphate catalyst in strong sulphuric acid. Part of the dichromate is reduced by organic matter and the excess is determined by titration with iron II sulphate using 1.10 - phenanthroline indicator. The method is highly applicable to the work and intereference free chloride is supressed by the addition of mercury II sulphate to the reaction mixture. COD is expressed as miligram of oxygen absorbed from standard dichromate per litre of sample.[8]

Apparatus

Antibumping granules, mercury II sulphate, silver sulphate 1.25% m/V, 98% m/m H_2SO_4, 0.125N iron II sulphate 0.125N Potassium dichromate and iron (II) - 1, 10 - Phenanthroline indicator solution.

Procedure

5ml of 0.125N Potassium dichromate, 10ml of concentrated sulphuric acid were transferred to a 250ml flat bottom flask and mixed well. It was cooled in a tray containing cold running water, 1ml of silver sulphate and 5ml of sample were added mixed well and fitted up to the condenser. A few antibumping granules were added and the mixture was boiled under reflux for two hours.

It was allowed to cool and 45ml of distilled water added, one drop of iron (II) - 1, 10-phenanthroline indicator solution was added and titrated against 0.125N iron II sulphate added from a five millitre microburette.

Blank Determination

The process was repeated with 5ml of distilled water in place of sample as blank determination.

$$COD = \frac{\text{Blank titration - sample titration}}{\text{Volume of sample taken (ml}} \times 1000$$

NB: The same quantity of mercurous sulphate was used in each sample determination, this in itself limits the results since this work does not measure the amount of chloride present before additing the mercurous sulphate and therefore unable to assess whether or not the chloride is actually totally suppressed or not.

3.7.5 Ammonia-Nitrogen Determination

Principle

Ammonia is quantitatively recovered by distillation under alkaline condition and determined colorimetrically after addition of Nessler's reagent.

Apparatus

Light magnesium oxide, ammonia free distilled water, Nessler's reagent. Ammonia standard solution.

Procedure

Distillation of Ammonia 50ml of the sample was placed in a flask and

0.25g of light magnesium oxide and sodium hydroxide were added. The distillation set up was fixed and rate adjusted to 10ml per minute. This was continued till about 30ml was obtained for each sample.

Preparation of Standards

The standard ammonia prepared was diluted 100 fold to produce 0.01mg NH_3 1ml 2.0, 4.0, 6.0, 8.0 and 10.0ml of the solution was transferred to 100ml volumetric flask, as well as a blank. They were each diluted to 5ml and 5ml of Nesslers reagent was added swirling the flasks. The corresponding solutions were diluted to volume and mixed well. The solution was allowed to stand for 30 minutes and their absorbance determined against the blank at 420nm. A calibration curve was constructed from results.

Sample Determination

20ml of condensate sample was placed in a hundred millilitre volumetric flask and a blank with distilled water was also prepared. 5ml of Nesslers reagent was added and the volume made up to the mark with ammonia free distilled water. The sample as well as the blank were again determined on UV spectrophotometer at 420nm. The corresponding values of ammonia were determined on the calibration curve.

3.7.6 Phenol Determination

The methods recommended for total phenol determination are the amino-antipyrine and the diazo methods. The former method was used in this work.[9]

Phenols determination with aminoantripyrine preparation of standards A freshly prepared solution of phenol 1g/1 was diluted 100 fold giving 1.0ml = 10mg phenol. 20, 40, 60, 80, 100, and 120ml were taken and each treated to 2ml of 5% NH_4Cl solution. The pH was adjusted to 10 with concentrated ammonia 2ml of 2% freshly prepared aqueous aminoantipyrine solution and 2ml 8% $K_3Fe(CN)_6$ solution were added. The absorbance was measured with the photometer at 510nm against a blank. A calibration curve of the absorbance was made.

Sample Determination After distillation and pretreatment processes, the same process above was repeated and the sample absorbances taken against a blank.

3.7.7 Determination of Metals

The samples were first pretreated for both dissolved and total metal determinations. Standards were prepared for each metal and by use of various dilutions series of concentration were made. Atomic absorption spectrophotometer which is recommended for determination of metals was used to read their transmittance and calibration curves were made. The samples under went the same procedure against a blank. Their metal concentrations were read from the calibration curves. All metal salts for standard determination were standardized by EDTA titration of pH 6 with aid of sodium hydroxide and ammonium chloride as buffers.

3.7.8 Chromium Determination

Chromium Standard Solution 0.283g of dried potassium dichromate was

dissolved in water and diluted to one litre 1.0ml = 100ug chromium 100ml of chromium standard solution was diluted to 500ml 1.0ml = 2.0ug Cr.

Treatment of samples, standards and blanks A small portion of any of the above was neutralized with ammonia solution. 10ml of 5% V/V Sulphuric acid, 0.40ml phosphoric acid and few drops of potassium permanganate 0.1N were added until color turned pink. 30ml of water were added. The mixture was heated on a water bath for 30 minutes and sodium azide was added and heated for another one minute till the color faded. The mixture was allowed to cool and 4ml of diphenyl semicarbazide was added. It was transferred to a 50ml volumetric flask and the volume made up to the mark for spectrophotometric determination, at 535nm.

3.7.9 Copper Determination

Copper Standard 0.393 of copper II sulphate $CuSO4.5H_2O$ was dissolved in water. 10ml of concentrated hydrochloric acid were added and finally diluted to one litre. 1.0ml = 100ug Cu.10ml of copper stock solution was diluted to 100ml with water 1.0ml = 10ugCu.

Treatment of Samples Standards and Blanks 2ml of ammonium hydroxide, 5ml of 20% ammonium citrate and 1.0ml of 0.1% sodium diethyldithiocarbamate, were added with mixing, with a pipette, 15ml of carbon tetrachloride were transferred to the mixture which was put in a 150ml of separatory funnel with 50ml of water. After shaking the layers were allowed to separate. The carbontetrachloride layer was removed and measured at 440nm on atomic

absorption spectrophotometer.

3.7.10 Lead

Lead Standard Solution 1.599g of lead nitrate, $PH(NO_3)_2$ was dissolved in water 10ml of concentrated nitric acid (16N) was added and the volume diluted to 1 litre. 1.0ml = 1.0mg Pb.10ml of lead stock solution was diluted to one litre 1.0ml = 10ug Pb.

Treatment of Samples Blank, and Standards 50ml of sample or relevant amount of standard was teken in a 100ml separatory funnel. The pH was adjusted to between 2 and 2.5. 20ml of dithizone stock solution in chloroform was added and shaken. The chloroform layer was discarded. This was repeated three times. To the aqueous layer was added 1.0ml of sodium hexametaphosphate solution, 1.0ml hydroxyl ammonium chloride solution, 10ml of alkaline cyanide solution and 0.5ml of dithizone working solution and 10ml of caloroform. The funnel was shaken with 2ml of chloroform layer allowed to waste and the rest measured at 510nm at the atomic absorption spectro photometer.

3.7.11 Zinc

Zinc Standards 0.440g of Zinc sulphate heptahydrate $ZnSO_4 7H_2O$ was measured dried and dissolved in such a way that 1.0ml = 1.0mg Zn.

Treatment of Samples Blanks and Standards Samples for Zinc as well as standards only underwent the general pretreatment for metals and they were straight away subjected to spectrophotometric tests.

CHAPTER IV

RESULTS

This chapter contains tables of results of the parameter monitored.

They re expressed in mg/l except where otherwise stated. Their abbreviations are the same as those explained in the earlier chapter. SD means standard of deviation. Number of determinations per parameter vary from 5 to 9. BD means below detectable limit.

Table 4.2 Results Monitored on NBL Discharge

Parameters		Average Values SD
Temperature	^{o}C	31.3 ± 0.7
pH		6.1 ± 0.7
Conductivity	umhos	226 ± 7
Suspended Solids	mg/l	74 ± 4
COD	mg/l	743 ± 11
Ammonia - N	mg/l	0.004 ± 0.0003
Phenols	mg/l	0.4 ± 0.03

Table 4.1 Results Monitored on NNTL Discharge

Parameters		Average Value SD
Temperature	°C	31.3 ± 0.9
pH		9.9 ± 0.2
E Conductivity	umhos	3450 ± 70
Suspended Solids	mg/l	125 ± 6
COD	mg/l	650 ± 18
Ammonia - N.	mg/l	0.0014 ± 0.0001
Phenols	mg/l	0.59 ± 0.02
Chromium (Total)	mg/l	0.68 ± 0.05
Zinc "	mg/l	0.48 ± 0.4
Lead "	mg/l	0.78 ± 0.02
Copper "	mg/l	0.80 ± 0.06

Table 4.3 Results Monitored on KTL Discharge

Parameters		Average Values SD
Temperature	°C	33 ± 7
pH	Umhos	10 ± 0.2
Conductivity	mg/l	2000 ± 61
Suspended Solids	mg/l	135 ± 3
COD	mg/l	572 ± 7
Ammonia - N.	mg/l	0.00527 ± 0.0003
Phenols	mg/l	0.56 ± 0.031
Chromium (Total)	mg/l	0.51 ± 0.036
Zinc "	mg/l	0.45 ± 0.039
Lead "	mg/l	0.67 ± 0.032
Copper "	mg/l	0.80 ± 0.018

Table 4.4 Results Monitored on UNTL Discharge

Parameters		Average Values SD
Temperature	°C	31 ± 0.5
pH	umhos	11 ± 0.2
Conductivity	mg/l	8927 ± 33
Suspended Solids	mg/l	133 ± 2
COD	mg/l	433 ± 7
Ammonia - N	mg/l	0.0052 ± 0.00015
Phenols	mg/l	0.61 ± 0.041
Chromium (Total)	mg/l	0.75 ± 0.37
Zinc "	mg/l	0.57 ± 0.027
Lead "	mg/l	0.79 ± 0.040
Copper "	mg/l	0.98 ± 0.040

Table 4.5 Results Monitored on Changi Changi Oil Depot Discharge

Parameters		Average Values SD
Oil and Grease	mg/l	8.7 ± 1
Chromium	mg/l	BD ±
Zinc	mg/l	0.153 ± 0.03
Lead	mg/l	0.30 ± 0.02
Copper	mg/l	0.14 ± 0.09

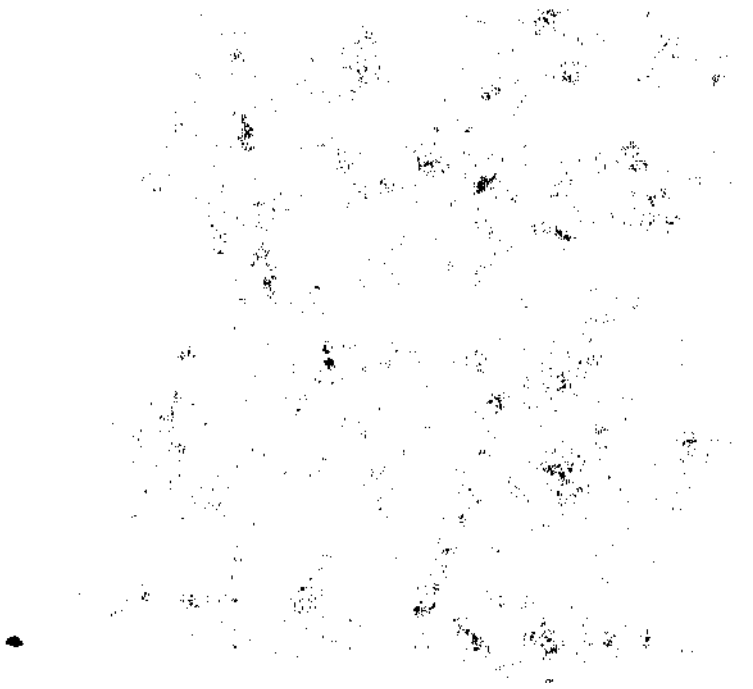


Table 4.6 Results Monitored on Arewa Tedtiles Discharge

Parameters		Average Values SD
Temperature	^{o}C	35.7 ± 0.9
pH	umhos	11.3 ± 0.2
Conductivity	mg/l	4041 ± 138
Suspended Solids	mg/l	82.4 ± 2.3
COD	mg/l	482 ± 14.4
Ammonia - N	mg/l	0.0036 ± 0.00033
Phenols	mg/l	0.49 ± 0.0002
Chromium (Total)		0.40 ± 0.0002
Zinc	"	0.47 ± 0.049
Lead	"	0.46 ± 0.042
Copper	"	0.38 ± 0.022

Table 4.7 Results Monitored on Turners Asbestos Products

Parameters		Average Values SD
Temperature	^{o}C	29 ± 3
pH	umhos	7.9 ± 0.1
Conductivity	mg/l	1812 ± 44
Suspended Solids	mg/l	152.6 ± 3
COD	mg/l	119 ± 3
Ammonia	mg/l	0.0023 ± 0.00013
Phenols	mg/l	0.42 ± 0.033

Table 4.8 Results Monitored on F.S.F.C. Discharge

Temperature		Average Values SD
Temperature	^{o}C	29 ± 0.5
pH		2.6 ± 0.1
Conductivity	umhos	4234 ± 78
Suspended Solids	mg/l	118 ± 5
COD	mg/l	152 ± 7
Ammonia - N	mg/l	0.0017 ± 0.00075
Phenols	mg/l	0.12 ± 0.063

Table 4.9 Results Monitored on Arewa Bottlers Co. discharge

Parameters		Average Values SD
Temperature	^{o}C	28 ± 0.4
pH	umhos	8 ± 0.4
Conductivity	mg/l	318 ± 13
Suspended Solids	mg/l	79 ± 2
COD	mg/l	304 ± 10
Ammonia - N	mg/l	0.0014 ± 0.00001
Phenols	mg/l	0.39 ± 0.014

Table 4.10 Results Monitored on PAN discharge

Parameters		Average Values SD n=9
Temperature	°C	27 ± 0.4
pH	umhos	7.3 ± 0.2
Conductivity	mg/l	288 ± 11
Suspended Solids	mg/l	84 ± 2
COD	mg/l	618 ± 18
Ammonia - N	mg/l	0.0019 ± -
Phenols	mg/l	0.03 ± 0.018
Chromium (Total)	mg/l	1.2 ± 0.048
Zinc "	mg/l	5.0 ± 0.0075
Lead "	mg/l	7.97 ± 0.13
Copper "	mg/l	0.095 ± 0.021
Oil and Greese	mg/l	0.18 ± 0.0125

Table 4.11 Results Monitored on *MISC. Industries discharge

Parameters		Average Values
Temperature	^{o}C	26 ± 0.3
pH	umhos	7 ± 0.1
Conductivity	mg/l	109 ± 6
Suspended Solids	mg/l	80 ± 2
COD	mg/l	419 ± 7
Ammonia - N	mg/l	0.0028 ± 0.0002
Phenols	mg/l	0.31 ± 0.130

*MISC. Industries means Miscellaneous Industries.

There are small industries occupying a small area near Peugeout Automobiles Ltd. They mainly produce metal pots and galvanised sheets. They are Tower galvanised sheets and Tower Alumium Ltd. They have a drain which hardly has effluents. And when they are present they are little in quantity.

Table 4.12 Results Monitored on Eslon PVC discharge

Parameters		Average Values	
Temperature	^{o}C	26.4	± 0.2
pH	umhos	7	± 0.2
Conductivity	mg/l	119	± 6
Suspended Solids	mg/l	101	± 5
COD	mg/l	582	± 9
Ammonia - N	mg/l	0.0022	± 0.00013
Phenols	mg/l	0.42	± 0.042

Table 4.13 Results Monitored on NNPC Refinery discharge

Parameters		Avcrage Values
Tmperature	^{o}C	26.4 ± 0.3
pH	umhos	7.4 ± 0.2
Conductivity	mg/l	417 ± 10
Suspended Solids	mg/l	80 ± 2
COD	mg/l	174 ± 6
Ammonia - N	mg/l	0.016 ± 0.00038
Phenols	mg/l	0.08 ± 0.015
Chromium (Total)	mg/l	0.17 ± 0.018
Zinc "	mg/l	0.27 ± 0.020
Lead "	mg/l	0.23 ± 0.029
Copper "	mg/l	0.10 ± 0.014
Oil and Greese	mg/l	1.65 ± 0.01

ANALYSIS REPORT FOR NBL

DATES (1981) PARAMETERS	28/7	6/7	13/8	II 21/8	I 21/8	I 5/9	II 5/9	I 18/9	II 18/9	8/12	11/12	24/9	4/10
Temperature ^{o}C	34.3	35.2	36.3	30.7	28.1	29.6	29.0	30.3	28.2	28.1	28.6		
pH	9.8	10.3	9.6	9.8	10.0	9.0	9.2	0.5	11.2	10.5	6.0		
Conducti-vity umho	3150	3090	3080	3650	3700	3600	3590	3600	3550	3000	220		
Suspended Solids mg/l	133	125.3	80.1	134.2	130.1	1320	129.3	131.2	1254	1250	83.7		
COD mg/l	740	680	720	610	630	680	590	580	590	700	500		
Ammonia-N mg/l						0.012	0.0013	0.0014	0.0016	0.0040	0.003		
Phenols mg/l	0.54	0.62	0.62	0.71	0.51	0.64	0.58	0.52	0.57	0.40	0.39		
Oils and Grease mg/l										1.2	2.2	BD	BD
Chromium mg/l	0.66	0.32	0.32	0.75	0.61	0.70	0.68	0.64	0.59	0.70	0.71	0.62	0.61
Zinc mg/l	0.38	0.63	0.29	0.30	0.32	0.35	0.37	0.31	0.29	0.60	0.82	0.41	0.61
Lead mg/l	0.60	0.60	0.55	0.58	0.55	0.66	0.71	0.72	0.63	0.77	0.66	0.86	0.81
Copper mg/l	0.40	0.72	0.45	0.28	0.22	0.30	0.28	0.38	0.26	0.95	0.31	0.71	0.81

ANALYSIS REPORT FOR NBL

Dates (1981) Parameters	28/7	6/5	13/8	21/8	21/8	5/9	3/99	18/9	18/92	18/12	11/12
Temperature °C	35.2	29.8	33.2	28.7	30.4	30.2	33.2	30.8	30.4	27.4	25.6
pH	11.0	6.3	5.9	5.7	4.6	4.5	5.2	5.8	5.8	6.0	6.0
Conductivity umho	260	230	210	210	240	220	215	200	230	250	220
Suspended solids mg/l	81	76.3	100.2	72.1	63.2	65.2	67.3	68.2	73.3	80.7	83.7
COD mg/l	700	760	730	690	770	740	770	740	790	400	500
Ammonia - N mg/l							0.0039	0.0042	0.0051	0.003	0.003
Phenols mg/l	0.57	0.52	0.52	0.28	0.21	0.37	0.30	0.31	0.36	0.22	0.10
Oils and grease mg/l										0.5	0.3
Chromium mg/l											
Zinc mg/l											
Lead mg/l											
Copper mg/l											

ANALYSIS REPORT FOR KTL

Dates 1981 Parameters	28/7	6/8	13/8	II 21/8	I 21/8	I 5/9	II 5/9	I 18/9	II 18/9	24/9	14/10	8/12	11/12
Temperature °C	33.5	32.2	35.0	29.3	33.2	32.3	33.3	35.5	33.5			30.2	29.5
pH	8.9	10.6	10.2	10.1	9.3	9.1	10.8	10.2	9.8			10.2	9.5
Conductivity umho	2200	2200	2300	1850	1900	1830	1800	1850	1880			2000	2000
Suspended Solids mg/l	153	142.8	135.7	132.2	127.1	137.0	127.2	130.0	128.2			130.1	133.2
COD mg/l	560	580	550	570	580	610	580	560	560			1600	1500
Ammonia-N mg/l						0.056	0.0055	0.0056	0.0044			0.006	0.008
Phenols mg/l	0.44	0.58	0.58	0.62	0.71	0.64	0.56	0.43	0.48			0.60	0.70
Oils and Grease mg/l										BD	BD	1.8	1.7
Chromium mg/l	0.62	0.82	0.71	0.50	0.60	0.66	0.60	0.63	0.52	0.47	0.48	0.72	0.80
Zinc mg/l	0.42	0.56	0.42	0.31	0.21	0.37	0.30	0.43	0.24	0.50	0.47	0.55	0.61
Lead mg/l	0.70	0.76	0.82	0.80	0.71	0.76	0.60	0.53	0.63	0.77	0.62	0.81	0.66
Copper mg/l	0.36	0.44	0.32	0.31	0.28	0.33	0.40	0.32	0.38	0.41	0.80	0.72	0.55

ANALYSIS REPORT FOR UNTL

Dates 1981 Parameters	28/7	6/8	13/8	21/8	21/8	5/8	5/8	18/9	18/9	8/12	11/12	24/8	14/10
Temperature °C	29.5	32.5	31.2	33.2	32.1	31.9	28.6	31.2	29.4	28.1	29.0		
pH	11.8	11.6	10.5	11.3	11.1	11.9	11.4	10.4	11.4	9.8	10.5		
Conductivity umhos	8870	8980	8880	8960	8800	8900	8855	9100	9010	9000	9000		
Suspended Solids mg/l	165	157.9	152.2	150.5	153.0	152.0	143.2	1330	140.1	130.2	1284		
COD mg/l	460	440	430	400	440	410	440	430	450	470	700		
Ammonia-N mg/l					0.0050	0.0051	0.0055	0.0056	0.002	0.003			
Phenols mg/l	0.38	0.70	0.70	0.63	0.75	0.68	0.59	0.52	0.57	0.42	0.39		
Oils and Grease mg/l										2.0	2.2	BD	BD
Chromium mg/l	0.70	0.85	0.60	0.68	0.75	0.71	669	0.58	0.32	0.85	0.71	0.76	0.59
Zinc mg/l	0.45	0.55	0.52	0.48	0.31	0.41	0.38	0.32	0.31	0.67	0.82	0.51	0.72
Lead mg/l	0.70	0.79	0.70	6.62	0.71	6.69	0.53	0.43	0.55	0.62	0.60	0.81	0.83
Copper mg/l	6.44	0.65	0.50	0.49	0.44	0.50	0.59		0.41	0.43	0.31	0.88	0.95

ANALYSIS REPORT FOR CH.O.D.

Dates 1981 Parameters	8/12	11/12	8/9	24/9	14/10
Temperature ^{o}C	24.5	22.1			
pH	6.0	6.3			
Conductivity umhos	150	140			
Suspended Solids mg/l	133.2	140.4			
COD mg/l	1400	850			
Ammonia-N mg/l	0.032	0.035			
Phenols mg/l	0.88	0.78			
Oils and grease mg/l	10.2	9.4		11.7	2.8
Chromium mg/l	BD	BD	BD	BD	BD
Zinc mg/l	0.19	0.10	0.10	0.20	0.21
Lead mg/l	0.30	0.25	BD	0.40	0.34
Copper mg/l	0.20	0.12	0.08	0.12	BD

ANALYSIS REPORT FOR CH.O.D.

Dates 1981 Parameters	8/12	11/12	8/9	24/9	14/10
Temperature ^{O}C	24.5	22.1			
pH	6.0	6.3			
Conductivity umhos	150	140			
Suspended Solids mg/l	133.2	140.4			
COD mg/l	1400	850			
Ammonia-N mg/l	0.032	0.035			
Phenols mg/l	0.88	0.78			
Oils and grease mg/l	10.2	9.4		11,7	2.8
Chromium mg/l	BD	BD	BD	BD	BD
Zinc mg/l	0.19	0.10	0.10	0.20	0.21
Lead mg/l	0.30	0.25	BD	0.40	0.34
Copper mg/l	0.20	0.12	0.08	0.12	BD

ANALYSIS REPORT FOR AT

Dates 1981 Parameters	28/7	6/8	13/8	21/8	5/9	5/9	18/9	18/9	24/9	24/9	4/10	8/12	11/12
Temperature °C	38	35.5	39.5	35.6	35.6	37.2	31.6	33.5				30.5	28.5
pH	11.7	11,1	10.8	11.6	11.9	11.2	11.9	.4	10.3			9.8	9.6
Conductivity umho	4390	4110	4370	4050	4200	4100	3150	4000	4000			4400	4500
Suspended Solids mg/l	97.4	89.7	88.3	77.2	81.5	81.2	77.1	75.1	76.2			70.2	72.1
COD Mg/l	480	420	450	550	530	520	480	460	450			500	500
Ammonia-N Mg/l						0.06	0.07	0.029	0.042			0.050	0.0045
Phenols mg/l	0.30	0.37	0.37	0.63	0.55	0.60	0.55	0.56	0.49			0.50	0.42
Oils and Grease mg/l										BD	BD	1.5	2.2
Chromium mg/	0.58	0.55	0.62	0.42	0.50	0.55	0.47	0.52	0.48	0.52	0.55	0.52	0.60
Zinc mg/l	0.40	0.66	0.30	0.50	0.40	0.32	0.34	0.34	0.22	0.60	0.41	0.48	0.51
Lead mg/l	0.80	1.00	0.77	0.71	0.81	0.77	0.82	0.82	0.71	0.52	0.48	0.51	0.39
Copper mg/l	0.34	0.50	0.30	0.35	0.44	0.40	0.35	0.34	0.43	0.52	0.30	0.41	0.44

ANALYSIS REPORT FOR TAP

Dates (1981) Parameters	28/7	6/8	1/8	II 21/8	I 21/8	I 5/9	II 5/9	II 18/9	II 18/9	8/12	11/12
Temperature °C	25.5	25.6	26.0	47.2	21.1	26.3	25.9	26.0	26.2	24.2	24.3
pH	7.9	8.0	8.5	8.2	7.7	7.3	1.3	7.4	8.2	8.2	7.5
Conductivity umhos	1900	2000	1905	1650	1600	1705	1750	2000	1800	1800	1500
Suspended Solids mg/l	166.0	151.8	140.3	160.1	152.2	161.2	159.8	140.4	141.5	101.5	95.5
COD mg/l	100	120	120	120	130	110	120	130	120	200	200
Ammonia-N mg/l						0.0022	0.0021	0.0024	0.0026	0.003	0.006
Phenols mg/l	0.38	0.40	0.40	0.39	0.32	0.38	0.42	0.62	0.51	0.44	0.36
Oils and Grease mg/l										1.5	2.1
Chromium mg/l											
Zinc mg/l											
Lead mg/l											
Copper mg/l											

ANALYSIS REPORT FOR rSFC

Dates (1981) Parameters	28/7	6/8	13/8	II 21/8	I 21/8	I 5/9	II 5/9	I 18/9	II 18/9	8/12	11/12
Temperature °C	30	27.2	29.0	31.2	29.1	29.0	28.1	27.1	26.3	26.0	26.0
Conductivity umhos	4400	4010	4050	4600	4500	4550	4000	4100	3900	3500	3100
Suspended Solids mg/l	137.4	133.4	142.0	121.5	119.0	122.7	98.2	93.3	94.1	92.4	87.5
pH	2.6	2.1	1.9	3.1	2.3	2.4	2.8	3.1	3.9	3.5	3.3
COD mg/l	120	160	140	160	180	150	170	140	150	200	180
Ammonia-N mg/l											
Phenols mg/l	0.40	0.10	BD	0.07	0.05	BD	0.09	0.02	BD	BD	BD
Oils and Grease mg/l										BD	BD
Chromium mg/l											
Zinc mg/l											
Lead mg/l											
Copper mg/l											

ANALYSIS REPORT FOR A.B.C.

Dates (1981) / Parameters				I 21/8	I 21/8	I 5/9	II 5/9	II 18/9	II 18/9		
Temperature °C	26.0	27.5	26.5	27.9	28.1	28.3	29.9	26.1	27.3	26.4	25.2
pH	6.2	6.9	7.2	8.3	9.7	9.6	8.1	8.2	7.8	8.2	7.9
Conductivity umhos	260	270	260	380	340	350	330	350	320	310	300
Suspended Solids mg/l	86.2	78.0	76.3	87.1	82.2	81.2	75.5	73.2	75.3	75.2	79.2
COD mg/l	260	300	290	270	300	320	350	320	330	300	300
Ammonia-N mg/l						0.0016	0.0014	0.0013	0.0014	0.026	0.007
Phenols mg/l	0.42	0.40	BD	0.40	0.31	0.42	0.38	0.42	0.33	0.25	0.31
Oils and Grease mg/l											
Chromium mg/l											
Zinc mg/l											
Lead mg/l											
Copper mg/l											

ANALYSIS REPORT FOR MISC. INDUSTRIES

Dates (1981) Parameters	28/7	6/8	13/8	21/8	21/8	5/9	5/9	18/9	18/9	8/12	11/12
Temperature °C	25.9	26.2	26.3	28.3	26.0	25.6	25.9	26.1	26.7	25.7	25.5
pH	6.8	6.9	6.5	7.5	7.3	7.7	7.7	6.9	6.9	7.9	6.2
Conductivity umho	6.8	105	95	140	120	155	12.5	90	100	130	120
Suspended Solids mg/l	82	77.3	81.3	78.3	70.4	82.3	85.0	88.8	78.1	80.2	77.9
COD mg/l	400	460	450	380	416	390	430	1440	410	300	100
Ammonia-N mg/l						0.0024	0.0029	0.0028	0.0032	0.001	0.001
Phenols mg/l	BD	0.44	0.44	BD	BD	BD	0.04	BD	BD	BD	BD
Oils and Grease mg/l										10.5	0.2

ANALYSIS REPORT FOR ELSON PVB

Dates (1981) Parameters	28/7	6/8	3/8	II 21/8	I 21/8	I 5/9	II 5/9	I 7/9	II 18/9	11/12	11/12
Temperature	26.2	25.5	27.3	26.2	26.2	26.2	26.9	25.8	26.3	25.5	26.0
pH	6.4	7.8	7.2	6.9	6.6	6.4	7.9	7.3	7.5	7.2	6.5
Conductivity umho	100	120	125	115	120	90	130	130	140	160	120
Suspended Solids mg/l	131.00	132.5	91.2	90.1	92.2	92.5	[illegible]	89.2	91.3	90.1	91.4
COD mg/l	600	640	610	510	560	570	590	580	580	550	450
Ammonia-N mg/l						0.0020	0.0021	0.0023	0.0025	0.0035	0.004
Phenols mg/l	0.60	0.59	0.59	0.37	0.22	0.30	0.35	0.35	0.37	0.25	0.5
Oils and Grease mg/l										4.2	BD
Chromium mg/l											
Zinc mg/l											
Lead mg/l											
Copper mg/l											

ANALYSIS REPORT FOR PAN

Dates (1981) Parameters	28/7	6/8	13/8	II 21/8	I 21/0	I 5/9	II 5/9	I 18/9	II 18/9	I 24/9	14/10	14.1	
Temperature °C	27.5	28.2	27.5	25.0	25.5	25.5	26.0	26.3	27.3			26.3	24.9
pH	6.8	8.1	7.8	7,3	6.2	6.8	7.8	7.?	7.8			6.8	7.2
Conductivity umho	270	310	393	240	280	250	300	240	310			300	320
Suspended Solids mg/l	83	91.2	88.2	86.2	87.3	89.3	77.9	[illegible]	79.4			85.3	83.3
Ammonia-N mg/l					0.001	0.0018	0.0019	0.0021	0.0018			0.010	0.009
Phenols mg/l	0.1	BD	BD	BD	0.01	0.01	BD	0.06	0.09			0.05	0.11
Oils and Grease mg/l										0.18	BD	4.2	5.5
Chromium mg/l	1.0	1.2	1.0	120	0900	1.10	1.20	1.33	1.30	1.5	0.9	1.5	2.0
Zinc mg/l	BD	BD	BD	6.05	BD	0.03	0.02	0.02	BD	4.0	6.2	5.1	6.1
Lead mg/l	BD	BD	0.1	1.20	1.1	0.90	0.95	0.77	0.65	7.8	7.2	8.3	9.2
Copper mg/l	0.1	BD	0.1	0.20	6.12	0.12	0.09	[illegible]	0.05	0.09	0.11	1.3	1.2

ANALYSIS FOR NNPC REFINERY

Dates 1981 Parameters	28/7	6/8	13/8	II 21/8	I 21/8	I 5/9	II 5/9	I 18/9	II 18/9	8/12	11/12	18/9	24/9	14/10
Temperature °C	27.5	26	27.2	26.4	26.2	26.5	26.5	25.2	26.2	25.3	24.0			
pH	8.5	8.2	8.6	7.1	6.6	6.4	6.9	7.	7.5	7.2	8.2			
Conductivity umho	460	400	450	390	370	400	430	410	440	460	400			
Suspended Solids mg/l	86.6	77.9	80.2	71.5	77.2	80.2	78.5	85.2	79.5	75	78.0			
COD mg/l	160	180	150	190	200	150	170	180	190	220	250			
Ammonia-N mg/l						0.0168	0.0158	0.0162	0.016	0.020	0.019			
Phenols	0.1	BD	0.10	BD	0.04	BD	BD	0.07	BD	BD	BD			
Chromium mg/l	0.28	0.34	0.22	0.32	0.33	0.23	0.31	0.21	0.37	0.30	0.40	0.17	BD	BD
Oils and Grease mg/l										2.5	3.2	BD	3.2	0.10
Zinc mg/l	0.23	0.33	0.30	0.25	0.30	0.20	0.15	0.20	0.17	0.20	0.25	0.20	0.30	0.31
Lead mg/l	0.40	0.56	0.55	0.35	0.33	0.30	0.35	0.42	0.41	0.51	0.32	0.26	0.20	0.25
Copper mg/l	BD	BD	0.10	0.03	BD	0.06	0.03	BD	0.04	0.1	BD	BD	0.10	BD

STANDARDS

ZINC

Conc. mg/l	Intensity
0.5	0.25
1.0	0.5
2.0	1.10
3.0	1.40
4.0	2.20
5.0	2.60
6.0	2.90

COPPER

Conc. mg/l	Intensity
0.1	0.012
0.2	0.029
0.4	0.043
0.6	0.067
0.8	0.91
1.0	0.117
1.2	0.132
1.4	0.156

LEAD

Conc. mg/l	Intensity
0.5	0.007
1.0	0.013
1.5	0.019
2.0	0.024
2.3	0.031
3.0	0.037
3.5	0.046
4.0	0.050
4.5	0.056
5.0	0.061
5.5	0.068
6.0	0.075
6.5	0.080
7.0	0.086
7.5	0.093
8.0	0.097

CHROMIUM

Conc. mg/l	Absorbance
0.2	0.06
0.4	0.11
0.6	0.15
0.8	0.21
1.0	0.26
1.2	0.33
1.4	0.37

PHENOL

Conc. mg/l	Intensity
0.05	0.035
0.10	0.060
0.15	0.10
0.20	0.12
0.25	0.17
0.30	0.20
0.35	0.23
0.40	0.26
0.45	0.28
0.50	0.33
0.55	0.36
0.60	0.3
0.65	0.4
0.70	0.45
0.75	0.49
0.80	0.52

CHAPTER V

DISCUSSION AND SUGGESTIONS

DISCUSSION

As greater emphasis is placed on water quality, public and political attention is even more strongly focussed on industry as a major water user and therefore as a major contributor to the pollutional burden. Industrial processing of almost every type and material generally results in greater concentrations of specific polutants than are found in domestic waste waters.[20] The relative simplicity in identifying and targeting a single industry as a polluter com, -ed to doing so in a commu: ty or area is the basis for asserting the above. For example it is not easy to assess how much the community in Kakuri section of Kaduna pollutes the river through Kakuri drain likewise Makera section. But it is easy to single out Federal Superphosphate Fertilizer Company as a polluter by simply analy, ing what it discharges into the Kakuri drain.

The emphasis laid on industrial wastes may in some cases be inproportionate especially with respect to pollution of a river which takes water from both industrial and domestic origin. However, the past and usually prevailing practice in dealing with municipal wastes and other waste

materials from specialized industrial undertakings containing diversified materials such as oil sludges, paint residues, spent or surplus pharmaceutical supplies, agricultural pesticides material from factory catastropes has been to dispose of such waste in the proximity of producers in a safe, unobstrusive and aesthetically acceptable site. Whether the Principal aim, to pose no threat to the water supplies and the environment in general has been achieved in this manner is highly improbable. Numerous examples may be cited from literature where ingnorance has undermined good intentions.

These altogether can be seen in better light if we study the processes in these industries inorder to aquaint ourselves with what goes into the drain treated or untreated.

Waste water from brewery industries emanate from steeping operations mainly. In the brewing process waste waters come from liquors pressed from grains and yiest recovery. Cooling waters also go out as waste waters.

In the textiles, scouring (the addition of alkaline agent, water and detergent) gives rise to solid particles and spent scour solutions which can cause about 2,8000-4000mg/l BOD.[21] They also contain high dissolved solids concentration high grease loading, fibrous material, inorganic salts, organic chemicals which are often toxic or biologically refractive and heavy metals. All these go into waste water treatment. Oil refinery waste water contain oil, water sand and silt plus some heavy metals, organic and corrosion-erosion products resulting from factory operations.[22] Other pollutants are phenol and cyanide. In the plastic industry the waste is in the form of aqueous solution of heavy metals, organic chemicals, oils and

greases.[23]

The superphosphate fertilizer industry in its sulphuric acid plant gives out waste water that contains sulphuric acid resulting from spillages and cooling waters.

All the pollutants contained in these waste waters are broadly classified into three:- The compatible pollutants, incompatible pollutants and the forbidden pollutants. The first category are those found in effluents obtained mainly in food beverages and organic industries. Examples of such industries are the N.B.L. and Arewa Bottlers. Such wastes are usually raw wastes similar to municipal wastes. Such wastes can be mixed in common sewers and treated at joint treatment plants.[24]

The incompatible pollutants are found in wastes that are incompatible with biological sewage treatment. The serious type of incompatibility is interference with the operation of treatment processes such as destruction or inhibition of biomass by toxid substances like cyanide, heavy metals, acids and petroleum based oils and grease.[25]

These substances in weak concentrations as the result in some cases show represent another type of incompatibility. In this case the pollutant neither affects nor is affected by the treatment process. It passes through the plant into the drain unchanged except for some degree of dilution.

The third grade of pollutants are those totally forbidden from entering municipal sewers or public water systems. These include flammable and explosive materials, corrosive waste, solid or viscous wastes that may cause obstruction and other interferences. According to N.P. Cheremisinoff

and associates waste steams can be declared hazardous if any of the following is applicable: contains radio active material, subject to bioconcentration, flammable, reactive, has oral LD50=50mg/kg toxic to inhalation less than 200 ppm as gas or mist, toxic to dermal penetration LD_{50} = 200mg/kg, phyto toxic IL50=1000mg/l or capable of causing genetic changes. The Royal Commission on sewage disposal in their eigth report (1912) considered the adoption of quality standards and proposed the adoptions two basic criteria BOD and suspended solids. It considered that a clean stream would morally have a BOD of 2mg/l and if it exceded 4mg/l the stream was on the verge of becoming a nuisance. On the basis that a normal treated sewage effluent should have quality of 30mg/l suspended solid and 20mg/l BOD (or the 30:20 standard), it can be shown that an eight times dilution with clean river water is required to prevent the BOD exceeding 4mg/l below the discharge. The 30.20 standard has beo widely adopted as conventic·al effluent quality standard.[33] Standards sho··ng levels of parameters in respect to tolerance levels in drinking water, irrigation, fish life and recreation are provided in this text. According to results obtained, apart from ammonia-nitrogen, all other parameters even with the conventional dilution factor are still above permissible standards. The pH values 11.32 and 2.59 for textiles and fertilizer effluents respectively is well out of normal to be allowed to enter the drains untreated.

The lowest BOD recorded in this work stands at 99.17 average value registered by Eslon P.V.C. pipes while the highest stands at 1,516.66

registered by Kaduna Textile Limited (all in mg/l). The least value of suspended solids registered by NBL is 74.09 mg/l while the highest is 152.58 mg/l by turners Asbestos products (TAP). All the remaining industries have values within these ranges for both BOD and suspended solids. If the 30.20 standard is anything to go by, then what goes into the drains is actually a nuisance. Drinking water standards permits not more than 0.05 mg/l of any of the heavy metals. Up to 0.78 and 0.022mg/l of zinc and Copper respectively can be toxic to fish. Only 0.001mg/l phenol can be permitted in drinking water, and ideal drinking water standards stand at 0.002mg/l, these are obtained from world Health Organization (WHO) standards and ideal water standards respectively.

Ammonia nitrogen however does not show threats in any of the effluents. The 30.20 effluent standards give maximum permissible limits of 2mg/l in water and only up to 3mg/l can cause toxicity to fish. The highest value of 0.016mg/l NH_3-H is recorded in NNPC refinery discharge drain.

On subsequent dilution this value will fall appreciably and should not pose problem.

The above is the situation in the industrial discharges existing with respect to the various parameters monitored. The trend has been shown to remain almost same for a monitor period of six months. Chemical oxygen demand (COD) owes a proportionality to BOD and expresses the total oxygen demand in most cases (including that belonging to BOD). Very high values of COD are registered by the textiles, but highest value is 743.33mg/l from NBL while the lowest is 118.89 registered by TAP. Phenols are found

in very high amounts in effluents. They still pose a threat in that ideal drinking water standards stand at 0.02mg/l while industries draining into Makera have figures like 0.59 (NNTL) 0.36 (NBL 0.56 (KTL) 0.61 UNTL) which will have to undergo appreciable amount of dilution before droping below ideal standards.

With regards to dissolved solids, the values of conductivity in umhos stand quite high for ground water irrigation. An amount of 8927.22 umhos given by UNTL can only add to the already not very good quality river water. As standards show, high levels of electrical conductivity in the soil destroys plant growth.

5.2 SUGGESTIONS

5.2.1 Waste Production and Treatment

An industrial plant faced with problem of disposing of its process waste water should first utilise all reasonable in plant measures to eliminate or reduce this waste at its source. The plant can then discharge only the portion of waste which cannot be bottled up or otherwise eliminated. Most of the times however, it is not possible to avoid production of certain grades of pollutants, but discharging them into the drains which empty into the river eventually is not only a violation of standards set but deliberate act of indecency. An attempt to treat wastes within the plant before discharge is emphasized by several environmental scientists. An initial step in treatment is the separation of solid phase that is present. This is done by filtration and sedimentation processes.

In the petroleum refinery industry, free oil is removed by sedimentation which produces a more polished effluent. Filtration alone would accomplish the same thing but the heavier loading on the filters would require more frequent back wash ng.

A special equipment namely the American Petroleum Institute (API) separator has been designed for waste waters carrying a high concentration of floatable oils such as those of petroleum refining. Emulsified an soluble oils, like dissolved solids cannot be removed by settling and require prior treatment usually by chemical additions.[27]

Chemical oxidation is another treatment step on effluents that can be relied upon. It is generally more costly than biological oxidation as a treatment technique but provides solutions suited for even resistant industrial wastes. Among he oxidants are air, oxygen, chlorine, ozone and sulphur dioxide.

The first two are relative weak but can be useful when used with microorganisms. Chlorine and ozone have broader applications, for pollutants that are difficult to oxidize such as ammonia, cyanide, phenolics and dye stuff. Sulphur dioxide in conjunction with sodium metabisulph 'e can reduce hexalent chromium to the more treatable trivalent state. This is done by first adjusting its pH to 3.0 and addition of sulphur dioxide. Heavy metals including trivalent chromium are converted to hydroxide and oxides which come out of solution by settling in batch tanks or in continuous settling basins by skimming. Air floatation can be used to improve the separation.

Gravity oil separator specified by API can be used to remove a greater part of floating oil in refinery waste waters although they do not break emulsions or separate dissolved solids.

The brewery industry due to its grade of waste waters may discharge into municipal sewerage systems with or without treatment. Treatment however consists of equalisation and screening made up of a screen house two strickling filters in series and a reactor-clarifier with sludge digestion. This assembly according to Gurnham and Associates (1976) removes 78% BOD_5 40% suspended solids.[28] The textiles wool grease is recovered by addition of acid to the batch to break the emulsion and free the grease. The aqueous phase is discarded after centrifuging the grease, or by evaporation to recover the grease.

Screening is applied to remove fibrous materials, sedimentation and polyelectrolyte addition separates away the solids.[29] Small particles and colloids are coagulated from the waste water by copera: lime or alum into larger particles to improve suspended solids separation.

Effluents that come out are usually alkaline and can be neutralized by additing acidic material to meet regulatory requirements or to protect subsequent treatment methods. Chlorine or hydrogen peroxide can be used to remove some dyes and destroy various biological organisms.

5.2.2 Waste Discharge and Waste Recycling

Waste waters containing compatible pollutants like those from NBL and Arewa Bottlers can be discharged into municipal sewage from common treatment but where it has to be discharged into public water ways primary treatment

may still be necessary. This include crude coarse screening and sedimentation which removed a substantial amount of suspended solids.

Effluents containing heavy metals especially zinc chromium, copper and lead are forbidden from entering public water ways untreated. They along with other pollutants like acids, petroleum based oils and grease contribute to destruction or inhibition of biomass or pass through the plant into the receiving stream unchanged except for a degree of dilution when in weak concentrations.

These must be removed or inactivated before these effluents can be discharged into the drains or public sewers. The United States Environmental pollution agency EPA indicates that the 1983 goal is zero discharge for textile mills.[29]

This can be achieved by reducing water use through recycling, and employing secondary biological treatment, clarification to remove suspended solids and reverse osmosis. This can be followed by a three-stage evaporation of the concentrated solution to a condensate suitable for recycling and a solid residue suitable for disposal. This therefore brings to mind the process of recovering of waste waters for re-use.

According to Robert Parlante (1930) recovering waste water for re-use is not an uncommon practice in industry. Closed recirculating cooling water systems with proper treatment have now replaced once-through cooling water systems because it is less expensive to re-use water even taking into account the additional equipment and chemicals required.

In many industrial plants, the water used once in a particular application is still of higher quality than the original raw water. Therefore, it can be cascaded or re-used in another application requiring lesser quality.

Current advances in unit production processes and waste water technology have placed in the hands of the industrial and chemical Engineer a wide range of versatile technique for practicing multiple internal circulation of water and effluents in manufacturing processes. The reclamation of effluents from the unit processes in a factory is recognised as an effective economic means of augumenting the water required for increased production output and for reducing water consumption per unit of production. Depending on the manufacturing plant, a saving in water consumption of between 50% and 95% can be achieved. It is in industry's own interest to practice water re-use and effluent reclamation as an integral part of industrial water supply. The effectiveness of this process depends on the material concerned and its usage. For example copper, mainly used in household pipelines becomes waste to an amount of 45% whereas recycling would reduce the annual loss of 5%.[31] Recycling and re-use will not only justify the continued existence of an industry but also ensure the future expansion of its production programme.

5.3 CONCLUSION

The numerous industries set up in Kaduna and elsewhere make use of water and after going through processes discharge waste waters of effluents, standards obtained from literature show the maximum permissible level of pollutants that these effluents should contain before getting into public

systems. A survey of fifteen industries in Kaduna City have been conducted with respect to their effluents. Results on the parameters clearly show that with evan the conservative conventional assumption of dilution and self purification, the amount of pollutants getting into the drains and subsequently into the river is a nuisance. This has been shown both in the Chapter of results and standards as well as in the chapter of discussion.

I have also carefully outlined the various effects, these pollutants have in the event of getting into groundwater (or irrigation), drinking water and aquatic life (in the river).

My studies on the Kaduna River have revealed that settlers by the river bank within and outside Kaduna town drink from river water. This is barely drinking a mixture of different industrial effluents inside the water.

Irrigation of land for vegetable production is a very common practice in Kaduna along both the river banks and the drains leading to the river.

Vegetables produced in this process will predictably contain high levels of these pollutants. High electrical conductivity and trace elements in the soil yield low quality crops especially tomato, rice, cotton, bean, corn, and spinach.

From effluents analysis too it can be deduced that some industries discharge their waste untreated into open drains. The results and the world standards show this clearly. Although this writer is not aiming at exposing erring industrialists in this country with respect to environmental pollution, he intends to put this work as raw as possible to every individual, organisation, or Government visa-vis the facilities available at our disposal to

Regular monitoring of effluents by all parties (industrialists, Government agencies and private researchers) independently and sometimes together will help. A stich in time saves nine stiches just as much as to be fore-warned is to be fore-armed.

A2. Desirable characteristics of good process water for Textile industries

Property	Desirable amount of Value
Suspended Solids	Less than 5 ppm.
Colour	0
pH	about 7.0
Hardness	Less than 20 ppm. as $CaCO_3$
Iron	Less than 0.2-0.5 ppm.
pH	about 7.0

A3. Classification of Surface Water Qualities

Parameter	Excellent	Acceptable	Polluted	Polluted	Heavily Polluted
pH	6.5-8.0	6.08.4	5.09.0	3.9-10.1	3.9-7.00
DO% Sat.	88-112	25-125	50-150	20.200	20-200
BOD_5mg O_2/l	1.5	3.0	6.0	12.0	12
NH_3mg N/L	1.0	0.3	0.9	2.7	2.7
Cl mg/l	50	150	300	650	620
Fe mg/l	0.1	0.3	0.9	2.7	2.7
S mg/l	09	1.0	3.5	8.5	72.7

A4. Standards for Trade Wastes

Trade effluents to be discharged into rivers or streams not include any of the following substances in proportions greatest than those stated below.

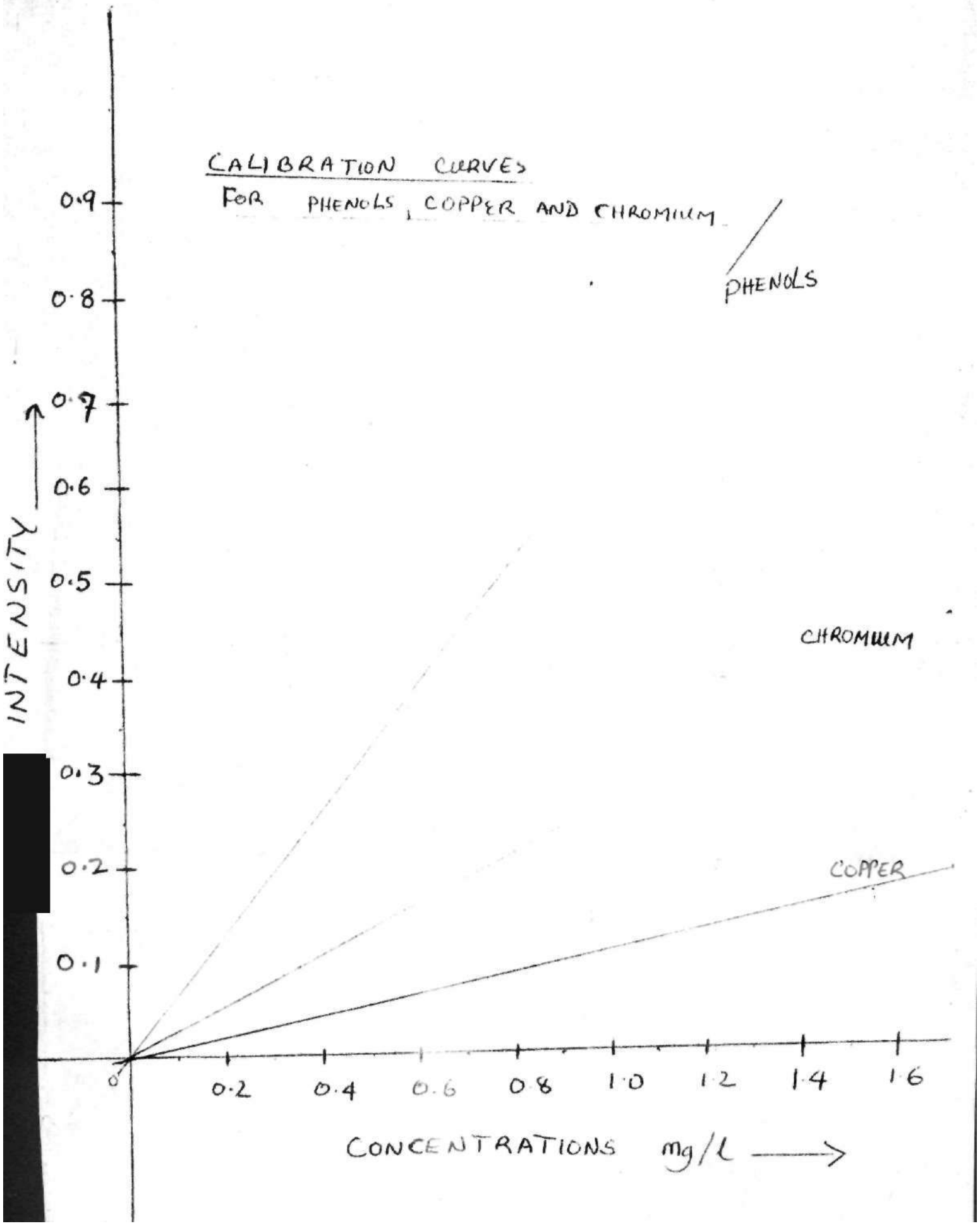
1.	pH	6-8
2.	Suspended Solid	30ppm
3.	Suspended and dissolved metals	30ppm
4.	Alkalinity as $CaCO_3$ mg/l	50ppm
5.	Free chlorine	1.0ppm
6.	Sulphides as H_2S	1.0ppm
7.	Penmanganate Value at 27°C	60ppm
8.	Cyanides at HCN	0.2ppm
9.	Temperature	
10.	Oil, grease, fat not more than	10ppm
11.	BOD at 20°C for 5 days	20ppm
12.	Phenols	1.0ppm
13.	Radioactive substances	None at all
14.	Arsenic Copper Chromium as Cr Mecury Selenium Lead Silver Zinc	Indiv lually or totally shall not exceed 1 ppm.

Flentje M. E., Quality Specification for Finished Water. Water quality and treatment. Handbook of Public water supplied. Mc Graw Hill Book Co., New York (3rd Ed. 1971).

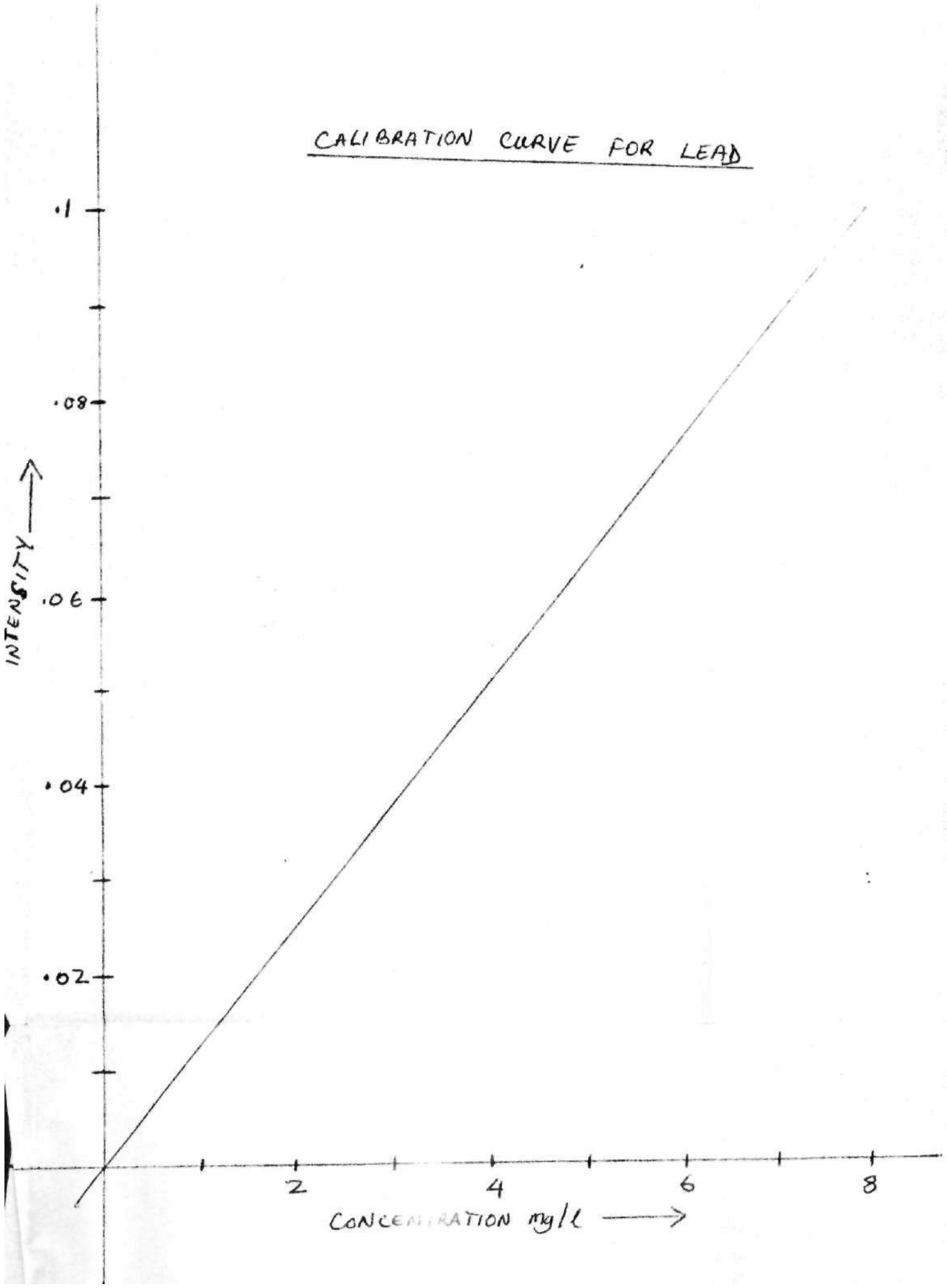
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CALIBRATION CURVES

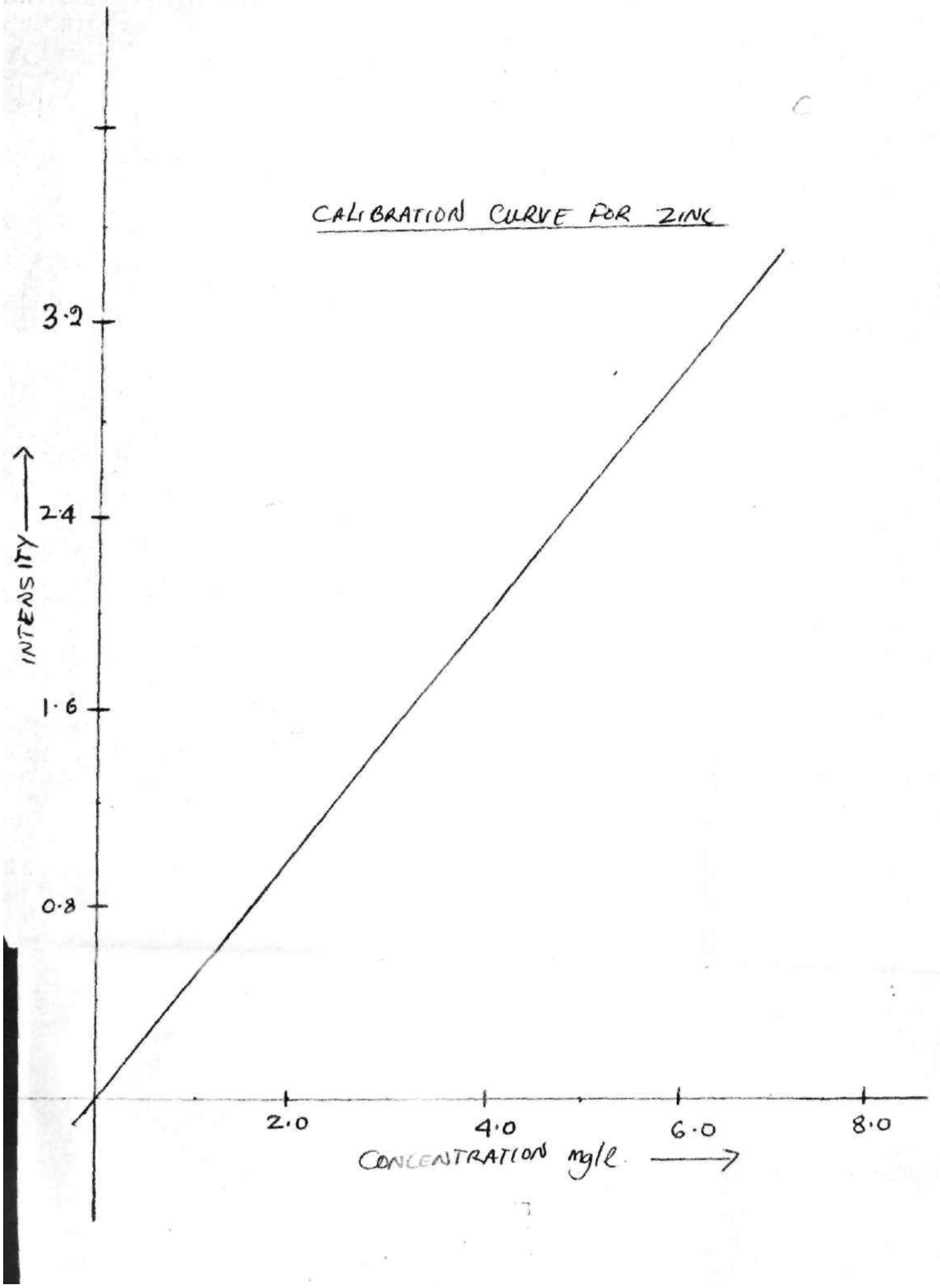
FOR PHENOLS, COPPER AND CHROMIUM



CALIBRATION CURVE FOR LEAD



CALIBRATION CURVE FOR ZINC



A5. Criteria for effluents from waste water Treatment Facilities located along the NGWERE Stream

Parameter	Maximum allowable limits in mg/l Except pH	Sampling Frequency per month
BOD_5 at 25°C filtered	5	2
BOD_5 at 25°C unfiltered	10	2
Dichromate value filtered	15	
Dichromate value unfiltered	30	2
Suspended Solids at	10	2
105°C Including algae	5	2
Ammoniacal Nitrogen	6.5-8.5	
pH		

Extracted from THE DESIGN OF A SURVELLANCE NETWORK FOR A WAST. -RECEIVING. AND WATER SUPPLY RIVER SYSTEM, WATER QUALITY REPORT W. Q.

BY

K. O. IWUGO, JANUARY, 1977

A6. Royal Commission Trade Effluent Standards
Working Standards for trade effluents
discharging to inland streams

pH Value	Between 5 and 9
Suspended Solids	Not more than 40ppm
Suspended Solids dissolved metals	Not more than 40ppm
Cyanides	Not more than 0.2ppm
Sulphide as H_2S	Not more than 1ppm
Oils and grease	Not more than 10ppm
Phenols	Not more than 1ppm
Free Chlorine	Not more than 1ppm
Zinc Cor. Silver Mercury Barium Lead	Individually shall not exceed 1.0ppm
Temperature	Effluent shall not exceed 32.5°C
BOD	40ppm.

A7. Typical composition of Domestic Waste Water

Parameter	Concentration mg/l	
	Range	typical
BOD_5	100-400	250
COD	200-100	500
N-Ammonia	10-50	25

ASPECTS OF RIVER POLLUTION. Klein Loius Page 561,
Extracted from water, wastes and Health in Hot Climates

By Richard Feachem. page 63
Michael Mc Gary
Duncan Mara.

A8. Proposed Stream Standards for Potable Water Supply WHO 71

Quality Parameter	Suggested level of stream Solid
pH	6.5 ~ 8.5
Dissolved oxygen	2mg/l
Arsenic	0.05mg/l
Pb.	0.05mg/l
Chromium Hexavalent	0.05mg/l
Cyanide	0.2mg/l
Phenolic substances	0.002mg/l
Chlorides	1000mg/l
TDS	4000mg/l

These reflect the quality requirements of potable water only in those aspects essential from a health view points. These are W.H.O. standards.

Proposed stream standards for fishing

Quality Parameter	Suggested level of stream standard
CO_2	12mg/l
pH	6.5 - 8.5
NH_3	1mg/l
Heavy metals	1mg/l
Copper	0.02mg/l
Arsenic	0.1mg/l
Selenium	0.1mg/l
Cyanides	0.012mg/l
Phenols	0.02mg/l
Dissolved solids	1000mg/l
Dissolved oxygen	2mg/l

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