WATER QUALITY ASSESSMENT OF ILOILO PORT WATERS

A THESIS

SUBMITTED TO:

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APPROVAL SHEET

This thesis entitled Water Quality Analysis of Iloilo Harbor Waters, prepared and submitted by Leo Theodore A. Ganzon, Lucky Rosen F. Nepomuceno and Aileene Rapas, in partial fulfillment of the requirements in Science Research II, has been examined and is recommended for acceptance and aprroval.

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This thesis is accepted and approved in partial fulfillment of the requirements in Science Research II.

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RESEARCHERS

ABSTRACT

The water quality of Iloilo Port was analyzed in terms of the concentration level of the concentration level of qualitative determinants: coliform bacteria, dissolved oxygen, sediments (dissolved and settleable), water pH, water temperature, salinity, and conductivity. These are all important factors in determining whether a body of water is polluted or not.

Four sampling stations were chosen in the site. Each of the determinants were read thrice each testing and then averaged. The testings were conducted on: July 26, October 4, November 7, and November 15. Temperature, salinity, conductivity, pH, and dissolved oxygen were determined on site. Dissolved and settleable sediments and coliform concentration were determined in the laboratory.

Results showed that the waters of Iloilo Harbor fall under the Department of Environment and Natural Resources Class SC waters or Recreational Waters Class II. This is a water classification suited for boating, and commercial and sustenance fishing. Although there were changes in the values of the different parameters with regards to the different testing sites, these are minimal and showed no significant variation in the water quality of the different areas in the harbor. The temperature range varied from 30.13 to 30.58 Celsius. The dissolved oxygen had a variation of 6.51 to 8.77 ppm. The pH varied from 6.36 to 6.89. The conductivity variation was from 51.22 to 51.39 ohms. Water salinity had a variation of 32.70 to 32.74 ppt. Coliform concentration ranged from 208.81 to 2154.82 MPN/100mL. The variation of dissolved solids concentration ranged from 26.65 to 30.92 g/L. The amount of settleable solids varied from 0.002 to 0.003 g/L.

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CHAPTER 1
INTRODUCTION

A. Rationale of the Study

Bodies of water have been used for trade and transportation for as long as people have gone to sea in boats. Nations and cities have developed based on their ability to utilize their access to the sea. Through technology more and better water vehicles are developed. Because of these, human activities in water increased, which lead to the gradual contamination and pollution of water.

Of the various bodies of water, ports and harbors tend to be most vulnerable to contamination for a number of reasons. Oil spills, dumped garbage, industrial and mining wastes are major factors in their pollution. These pollutants endanger plant and animal lives.

The Iloilo Harbor, like most harbors, plays a key role in Iloilo's economic situation. It is the city's center of trade and transportation. Ships from various provinces and cities like Manila, Guimaras, Negros, and Cebu dock and ferry passengers and cargoes in the port.

The researchers realized that since the harbor is significant in Iloilo's development, it is important to know its water quality. And since the harbor includes the fishing harbor, and a beach where people swim, it is important to find out if the water is fit for these activities.

B. Statement of the Problem

This research aims to assess Iloilo Harbor waters in terms of the concentration of biological, chemical and physical contaminants. Specifically, this will answer the questions:

- Do the physico-chemical properties of Ilioilo Harbor waters meet the quality standard set by the Department of Environment and Natural Resources ?
- Is the Iloilo Harbor safe enough for human activities?
- Are there specific areas where the concentration of pollutants are higher than the rest?

C. Objectives of the Study

This study is conducted with the following objectives:

- To determine the water quality of Iloilo Harbor in terms of the concentration level of coliform bacteria, dissolved oxygen, sediments, water pH, water temperature, salinity, and conductivity.
- To classify the water quality of Iloilo Harbor based on its physico-chemical characteristics and compare this to the water quality standard set by DENR.

D. Hypothesis of the Study

It is hypothesized in this research that the Iloilo Harbor is safe enough for human use. It is also hypothesized that the Iloilo Harbor waters meet the quality standard set by the DENR and that the water quality is the same in all areas.

E. Significance of the Study

This study is conducted to get a more comprehensive assessment of the Iloilo Harbor since it plays a key role in the economic situation of the whole province. The unsuitability or suitability of the harbor for human activities would affect the trade and transportation business of Iloilo.

F. Scope and Limitation

This research is limited to the water quality assessment of Iloilo Harbor in terms of seven determinants only - temperature, pH, dissolved oxygen, sediment, salinity, conductivity, and coliform bacteria. These determinants were tested in four sampling stations with three replicates for each station.

G. Definition of Tems

Coliform-members of family *Enterobacteriaceae* found in the colon or intestines.

Contaminated water - water containing either poisonous chemical or pathogeneic organism, yet still is clear and sparkling.

Dissolved oxygen -the amount of oxygen present which increases the palatability of water.

Enteric pathogens - organism found in the intestinal tract that could cause diseases.

Harbor - protected body of water where ships can find refuge from storms.

pH - the quantitative measure of the acidity or basicity of aqueous or other liquid solution.

Polluted water - water that may or may not be contaminated but has an undesirable appearance or taste.

Ports - harbors with wharves, warehouses, roads, and other facilities for handling ships and cargoes.

Temperature - the degree or intensity of sensible heat of a body or the atmosphere.

Suspended solids - the amount of particulate solids which is a factor of silting.

CHAPTER II
REVIEW OF RELATED LITERATURE

Water

Water is a substance composed of the chemical elements hydrogen and oxygen. It is one of the most abundant and essential compound. Water is vital to life, participating in virtually every process that occurs in plant and animals (Encyclopedia BritannicA 1992). It has high melting and boiling points (0 C, 212F) respectively. Its color in thick layers is blue due not only to physical reasons but also to suspended impurities.

Water Pollution

Water pollution involves the release into bodies of water of substances that become dissolved or suspended in the water or deposited upon the bottom and accumulate to the extent that they interfere with the processes of aquatic systems (Encyclopedia Britannica 1993). Suspended particles are the most frequent pollutants of water. Increasing use of fertilizers and pesticides,

farming operations, irrigation and drainage practices, municipal and agricultural wastes and other factors contributes to a general increase in water pollution (Soil and Water Conservation Engineering 1993).

Water Quality

The suitability of water for aquatic life and for human use depends on its quality (See Table 1). Water quality is determined by the concentration of biological, chemical, and physical contaminants - the amounts and kinds of suspended and dissolved substances, the degree of acidity or alkalinity (water pH), temperature, color and transparency, taste and odor, and the presence of undesirable organisms (Grollier Encyclopedia 1991).

Infectious Agents

Water is not a favorable medium for the growth and multiplication of microorganisms and yet many can survive in it long enough to carry infection to human beings. Cholera and thypoid are both waterborne diseases, and the virus hepatitis, too, can survive in water. But, the mere presence of a microorganism in water does not necessarily lead to the spread of disease. People have swum in water polluted with *salmonella thypi* , without getting thypoid while others eating shellfish from the same water have developed the disease. The same may be true of hepatitis. If such water is properly treated, it will be safe for use; if not, disease is sure to follow (Encyclopedia Britannica 1993).

Infectious agents present in water are usually pathogenic bacteria, viruses, and protozoan. These come from 1)untreated or improperly treated sewage, 2)animal waste, 3) meat packing and tanning plants, and 4)some wildlife species that transmit water borne

diseases. In LDC's these organisms are the biggest cause of sickness and death, prematurely killing an average of 13 700 people each day, half of them children under five (Miller 1995).

Coliform

A good indicator of the quality of water for drinking or swimming is the number of colonies of coliform bacteria in a 100-milliliter (0.1 quart) sample of water (Miller 1995). *Eschirichia coli* , or fecal coliform, inhabit human intestines in colossal number. These are any non-sporing facultatively aneraobic bacillus which can ferment lactose within 48 hours with the formation of acid and gas at 37C (Singleton 1995). The coliform bacterium is not necessarily harmful in itself. However, in waters where there are existing coliform bacteria, enteric pathogens are presumed to be present (Volts 1992). Coliform is the most reliable index of pollution. This organism is the most widely accepted indicator of water quality in the U.S. (Popular Science 1993). Coliform bacteria is the indicator of the presence of thypoid and dysentery. The reported coliform will not and will never cause thypoid, fever, diarrhea, cholera or amoebiasis in a human body (Manila Bulletin 13 August 1997).

Indication of Contamination

The World Health Organization recommends a coliform bacteria count of 0 colonies per 100 milliliters for drinking water, and the EPA recommends a maximum level for swimming water of 200 colonies per 100 milliliters (Miller 1995). If fecal coliform counts are higher, then there is a great chance that pathogenic organisms are also present. If a person swims in this waters, he or she has a greater chance of getting sick from swallowing the water or from the pathogens entering the body through cuts in the skin, nose, mouth or even the ears. The types of sickness you can get from these pathogenic organisms include thypoid fever, hepatitis, gastroenteritis, dysentery, and ear infections. It was estimated that fecal concentration of 200 per 100 ml would cause 8 illnesses per 1000 swimmers, at fresh water beaches, and 19 illnesses per 1000 swimmers at marine beaches (USEPA 1986).

pH

pH refers to the measurement of acidity and alkalinity of water. Acidity exerts a controlling influence on the chemistry of many elements. It is one of the limiting factors to an ecosystem and its organism. Low pH conditions may limit the occurrence of organism (McGraw-Hill Encyclopedia of Environmental Science and Engineering 1992). A combination of a pH of 5.0-5.5 and high concentrations of aluminum in calcium-deficient waters can cause physiological changes in fishes that result to death

(Environmental Issues in the 1990s 1992). pH also helps determine the concentration of contaminants and pollutants in water. Pollutants are markedly affected by pH changes. These changes in acidity or alkalinity can make it highly poisonous. It thus makes an aquatic ecosystem dangerously incapable of sustaining life and has organisms present be too toxic to be eaten, leading to the death of the ecosystem.

Temperature

Temperature is the degree or intensity of sensible heat of a body or of the atmosphere. It is a significant qualitative factor because it influences the metabolic rate of aquatic organisms and the rate of chemical reactions in the body of water. The discharged heated body of water in a waterway increases temperature, accelerates chemical and biological processes. It also decreases the ability of water to hold dissolved oxygen. Thus, increased temperature often cause ecological imbalance, sometimes resulting in major fish kills near the discharged source. Thermal changes affect the aquatic system by limiting or changing the type of fish and aquatic biota able to grow or reproduce in the water. Thus, rapid and dramatic changes in biologic communities often occur in the vicinity of heated discharge (Grollier Encyclopedia of Knowledge 1991). Thus, it can be said that significant increase of temperature cause by industrial discharge of heated water maybe detrimental to aquatic life a condition termed as thermal pollution. Increases of about 2C are known to seriously affect fishes and other aquatic life. Increasing

water temperature also raises the metabolic rate in organisms, and also increases oxygen requirements, although there is less oxygen present at high temperature (Environmental Issues in the 1990s 1992).

The discharge of temperature from electric power plant (see plate 5) generally range from 5 to 11 C degrees above ambient water temperature.

Dissolved Oxygen

Measuring dissolved oxygen is one way of telling how healthy a body of water is. A high level of oxygen indicates that a pond or stream is a good place for plant and animal life (Fleisber 1994). This is because oxygen is utilized in the respiration of organisms as in the decomposition of organic matter generating the continuity of the oxygen cycle.

Animals that live in water depend on dissolved oxygen for life. A marked decrease of dissolved oxygen because of bacterial decay of organic wastes has been a major force in water pollution (Grollier Encyclopedia of Knowledge 1991).

Dissolved oxygen in water has no adverse physiological effects and actually increases the palatability of water (California State Water Board Control 1963).

Conductivity

Conductivity measure in terms of m/s refers to the ability of water to conduct electricity. This chemical characteristic of water is directly proportional to the number of cations present in water. Conductivity is primarily attributed to larger cation quantity present in aquatic habitats that affect the ability of water to conduct electricity.

Different organisms are affected by the rate of flow of current in terms of electricity. *Caloneis silicula*, for example, is a species affected by high current (Amansec 1993).

Salinity

Salinity, the measure of salt present in water, is expressed per mil. Sodium and chlorine are the principle elements that contribute to salinity. More than 99% of water's salinity is caused by ions such as sulfate (7.72%), magnesium (3.68%), calcium(1.17%), potassium (1.1%), bicarbonate (0.4%), bromine(0.19%) and chloride(55.07%) and sodium(30.62%).

Some source of these ions are dusts, gaseous liquid, and solid pollutants released through human activity carried directly into the ocean or carried by the sea or polluted air.

Sediments

Sediments or suspended matter are the interface o f soil or other geologic feature on surface water. They are composed of native materials that predate inundation by water, such as sand, bedrock, and clays; water from both surface and ground source; materials both organic and mined washed into the water body; and pesticides generated into the water body, such as planktons, frustules, fecal material, or organisms (Maughan 1993)

By weight, this is so far the biggest water pollutant. Sediments cloud water and reduce photosynthesis, it also disrupts aquatic food webs, and carries pesticides, bacteria, and other harmful substances. Sediments that settles out destroys feeding and spawning grounds of fishes, and clogs and fills lakes (Miller 1995). Eroded sediments not only indicate an erosion loss, but carry attached chemical ions, such as phosphorous and potassium that contribute to chemical pollution (Schwab et al. 1993).

The Iloilo Harbor

The Iloilo Harbor is a vital part of Iloilo's economy. It is one of Iloilo's sources of income, goods, and transportation.

A harbor is any natural or artificial protected body of water where ships find shelter and refuge from storms or while making repairs. When provided with wharves, warehouses and other facilities, a harbor becomes a port (Grollier Encyclopedia of Knowledge 1993). The Iloilo harbor contains several ports.

The Iloilo Harbor is a commercial harbor. Thus, it is designed primarily for commercial purposes. It is provided for the formation of ports within their shelter, or for the protection from the approaches of ports near the sea coast, or on large rivers. The docks of a commercial harbor keep the water at the same level for the discharge of cargo etc. The Iloilo Harbor is a good commercial harbor because it has ample supply of machines for cargo removal and transport, plenty quay space, good warehouses, and navigational aids.

Coastal and Marine Waters Classification

SA - Waters suitable for propagation, survival and harvesting of shellfish for commercial purposes;

- Tourist zones and national marine parks and reserves established under Presidential Proclamation No. 1801; existing laws and/or declared as such appropriate by government agency.

SB - Recreational Waters Class I (Areas regularly used by public for bathing, swimming, skin-diving etc.)

- Fishery Waters Class I (Spawning areas for *Chanos Chanos* or bangus and similar species).

SC - Recreational Waters Class II (e.g. boating)

- Fishery Waters Class II (Commercial and Sustenance Fishing)

- Marshy and/or mangrove areas declared as fish and wildlife sanctuaries.

SD - Industrial Water Supply Class II (e.g. cooling - Other coastline and marine waters, by their quality, belong to this classification.

Table 1. Water Quality Criteria for Conventional and other Pollutants affecting aesthetic and exerting oxygen demand for coastal and marine waters.

PARAMETER	UNIT	CLASS SA	CLASS SB	CLASS SC	CLASS SD
Color	PCU	(C)	(C)	(C)	(C)
Temperature (max. rise in degrees celsius)	C rise	3	3	3	3
pH Range		6.5-8.5	6.0-8.5	6.0-8.5	6.0-9.0
D.Oxygen (maximum)	%SATN	70	70	70	50
	mg/L	5.0	5.0	5.0	2.0
5-day 20C BOD	mg/L	3	5	7/(10)	-
Total Suspended Solids	mg/L	f	g	g	h
Total Coliforms	MPN/ 100 mL	70	1000	5000	-
Fecal Coliforms	MPN/ 100 mL	nil	200	-	-

CHAPTER III

METHODOLOGY

A. MATERIALS

Thermometer
DO meter
volumetric flasks
5 100mL
5 50mL
pippette
15, 5, 1 cc
autoclave
dilution bottles
60 Durnham tubes
5 test tube racks
hot plate
stirring rod
pH meter
Conductivity apparatus
spectrophotometer
graduated cylinder
dropper
incubator
lactose broth
brilliant green lactose bile broth
evaporating dishes
60 test tubes
triple beam balance
1000 ml beaker

B. Study Area and Sampling Sites

The study area, Iloilo harbor, is located northeast of Ilolilo's city proper. It is one of the most important factors in the trade, fishing, and transportation industry of the province

There were four sampling stations chosen, one near the fishport, one between the harbor and Guimaras, and another two between these. Figure 1 Shows the sampling area.

C. Water Collection

The following determinants were tested on site for each sampling station : temperature, pH, dissolved oxygen, salinity, and conductivity.

Three water samples were collected for each sampling site and then placed in sterilized glass jars and mineral water bottles.

The following determinants were tested at the PSHS-WVC laboratory: phosphates, nitrates, and coliform concentration.

D. Temperature Determination

1. A thermometer was used to determine the temperature of the sampling site
2. The bulb of the thermometer was dipped 2 cm. below the surface of the water and readings were recorded.
3. The procedure was repeated thrice and the readings were average

E. pH Determination

1. The pH meter was neutralized by washing it with distilled water. It was then calibrated through immersion in a buffer solution.

2. The pH meter was then immersed in the sampling site and results were recorded.

3. The procedure was repeated thrice and the results were averaged.

F. Dissolved Oxygen Determination

1. The dissolved oxygen meter sensors was dipped in the sampling site. The results were recorded.

2. The procedure was repeated thrice and the readings were averaged.

G. Salinity and Conductivity Determination

1. The conductivity/salinity apparatus sensor was dipped in the sampling station. The results were recorded for each determinant.

2. The procedure is repeated thrice and the readings were averaged.

H. Solid Concentration Determination

A. Total Settleable Solids

1. 100 mL of water samples were placed in a graduated cylinder.

2. 3 replicates for each station were collected.

3. The volume of settled solids were read after 24 hours left standing.

B. Dissolved Solid Concentration

1. The weight of an evaporating dish was measured.

2. 30 ml of the samples were placed in the evaporating dish.

3. The evaporating dish with the samples was placed in a hot plate.

4. After the water has evaporated, the evaporating dish was weighed.

5. The amount of dissolved solid was determined subtracting the initial weight of the evaporating dish from the final weight.

J. Coliform Concentration Determination

J.I Presumptive test

1. The water sample from sampling station 1 was shook 25 times by making up and down or back and forth movements.

2. The water sample was diluted to 0.1 and 0.01 concentration.

3. 10 ml of the pure water sample was placed in a sterile dilution bottle containing 100 ml of distilled water. The bottle was shook and labeled 0.1/1

4. 10 ml of water sample from the bottle labeled 0.01/1 was placed in a jar containing 100 ml of distilled water. The bottle was shook and labeled 0.01/1.

5. 1 mL of the pure water sample was pipette into five tubes of primary lactose broth labeled 1/1.

6. 10 ml of the water sample from the 0.1/1 bottle was pipetted into each five primary lactose broth labeled 0.1/1.

7. 10 ml of the water sample fro, the 0.01/1 bottle was pipetted into each five primary lactose broth labeled 0.1/1.

9. The procedure was repeated for each sampling station.

10. The test tubes were incubated at 35C for 24 hours.

11. At the end of 48 hours, absence or presence of gas formation was recorded.

J.2 Confirmatory Test

For Brilliant Green Lactose Bile Broth

1. The test tubes showing was gently shook.

2. With a sterile metal loop 3-mm in diameter, one loopful of medium was transferred to BGLB (Brilliant Green Lactose Bile Broth).

3. The inoculated tubes were incubated for 24-48 hours at 35C.

J3. Completed Test

1. The Brilliant Green Lactose Bile Broth tubes showing gas were shook.

2. Water sample was transferred from the BLBG tubes to tubes containing secondary lactose bile broth by dipping a sterile wire loop.

3. The tubes were incubated for 24+/24-2 or 48 +/48-3 hours at 35C.

J.4 Calculating for the MPN (Most Probable Number)

1. Summarize the results.

2. Then, substitute the valies to the equation:

$$\text{MPN/100mL} = \frac{\text{no. of tubes positive x 100}}{[(\text{mL sample in neg. tube})(\text{ml sample in all tubes})]^{1/2}}$$

K. Statistical Analysis

1. Duncan's Multiple Range Test - used to separate a set of significantly different means into subsets of homogenous means.

2. Two-Way Classifications - test used in order to classify obesrvations to two criteria at once by means of a rectangular array in which the columns represent one criterion and the rows the second.

CHAPTER IV

RESULTS AND OBSERVATIONS

TABLE 2. WATER QUALITY OF THE DIFFERENT SAMPLING SITES TAKEN ON JULY 26, 1998. VALUES ARE THE MEAN OF THREE DETERMINATIONS.

	WATER QUALITY DETERMINANT				
SAMPLING STATION	SALINITY (PPT)	Ph	TEMPERATURE (^{o}C)	DO (PPM)	CONDUCTIVITY (OHMS)
1	33.3	7.44	30.9 C	6.12	52.37 m/s
2	33.16	7.66	30.9 C	6.29	52.73 m/s
3	33.09	7.48	30.9 C	8.03	53.90 m/s
4	33.10	7.44	31.0 C	8.19	53.88 m/s
OVER-ALL MEAN	33.16	7.54	30.93 C	7.16	53.24 m/s

TABLE 3. WATER QUALITY OF THE DIFFERENT SAMPLING SITES TAKEN ON OCTOBER 4, 1998. VALUES ARE THE MEAN OF THREE DETERMINATIONS.

	WATER QUALITY DETERMINANT						
SAMPLING STATION	SALINITY (PPT)	Ph	TEMPERATURE (^{o}C)	DO (PPM)	CONDUCTIVITY (OHMS)	SOLIDS	
						DISS. (g/l)	SETTLED (g/l)
1	32.63	6.14	29.60 C	4.99	51.80	31.60	0.02
2	32.90	6.05	29.80 C	4.84	51.93	28.40	0.03
3	32.80	6.13	29.90 C	4.83	50.40	25.40	0.025
4	32.90	6.14	30.00 C	5.61	50.40	30.00	0.03
OVER-ALL MEAN	32.81	6.12	29.85 C	5.06	51.13	28.85	0.027

TABLE 4. WATER QUALITY OF THE DIFFERENT SAMPLING SITES TAKEN ON NOVEMBER 7, 1998. VALUES ARE THE MEAN OF THREE DETERMINATIONS.

	WATER QUALITY DETERMINANT						
SAMPLING STATION	SALINITY (PPT)	Ph	TEMPERATURE (^{o}C)	DO (PPM)	CONDUCTIVITY (OHMS)	SOLIDS	
						DISS. (g/l)	SETTLED (g/l)
1	32.30	5.50	29.90C	10.62	49.50	28.79	0.02
2	32.23	6.00	30.10 C	10.66	49.50	26.35	0.035
3	32.2	7.05	29.93 C	12.66	49.50	27.90	0.03
4	32.2	7.10	30.13 C	12.51	49.50	30.84	0.02
OVER-ALL MEAN	32.2	6.41	30.02 C	11.69	49.50	28.46	0.0265

Table 5. Water Quality of Iloilo Port Waters. Values are the mean +S.D. of the results of the testings on July 26, Oct. 4, and Nov. 7 of 1998.

SAMPLING STATION	TEMPERATURE (^{o}C)	DO (PPM)	Ph	CONDUCTIVITY (OHMS)	SALINITY (PPT)
1	30.13	7.24	6.36	51.22	32.74
2	30.20	7.26	6.57	51.39	32.76
3	30.24	6.51	6.89	51.29	32.70
4	30.38	8.27	6.93	51.26	32.73
OVERALL MEAN	30.24±0.09	7.55±0.89	6.69±0.23	51.29±0.06	32.73±0.02

SAMPLING STATION	DISSOLVED SOLIDS (G/l)	SETTLEABLE SOLIDS
1	30.17	0.020
2	27.38	0.033
3	26.65	0.028
4	30.42	0.027
OVERALL MEAN	28.86±1.66	0.027±0.005

CHAPTER V

SUMMARY, CONCLUSION AND RECOMMENDATIONS

It can be observed from the three testings , on July 26, October 4, and November 7, that conductivity, salinity, temperature, and dissolved solids are relatively constant. There were very slight variations in the values collected. The temperature and salinity were generally uniform during all the testings in all the sampling stations. pH, dissolved oxygen, and coliform concentration, on the other hand, are highly erratic. There is a recognizable difference on every testing in different sites. Coliform concentration, however, remained uniform. Its concentration was highest in sample station 3 on the water samples collected on November 7. It still had the highest concentration during the sample analysis of the November 15 water sample analysis. While site two remained consistently as having the least concentration of coliform.

Table 6.

Coliform concentration of Iloilo Port Waters. Values are the means of two determinations.

Sampling Station	November 7 (MPN/100mL)	November 15 (MPN/100mL)
1	351.00	237.29
2	222.95	194.66
3	1369.63	2940.81
4	241.00	244.26

This is indicated by the high concentration of pathogenic organisms (e.g. coliform). Water samples from Site 4, the site between Guimaras Island and the Port, on the other hand had lower concentration of pollutants.

Different sites in the Iloilo Port have uniform qualities of water. Although sites frequently used for human activities are more polluted and contaminated, the variation with the less frequently used areas

are not significant. Thus, all the sites fall under DENR's classification of "waters safe enough for human use".

The researchers recommend that on further studies about the quality of different bodies of water more determinants should be used such as the concentration of some harmful chemicals such as nitrate or phosphate. It is also recommended that studies on factors affecting these determinants should also be studied. The relationship between water quality and other environmental factors such as weather, and human activities are recommended for further studies.

For frequent users of bodies of waters (e.g. swimmers and boaters) who wish to enjoy their activities there, it is recommended that they first be familiarized with the condition of the water to avoid harm. Thus, it is also recommended that all bodies of water should be thoroughly analyzed.

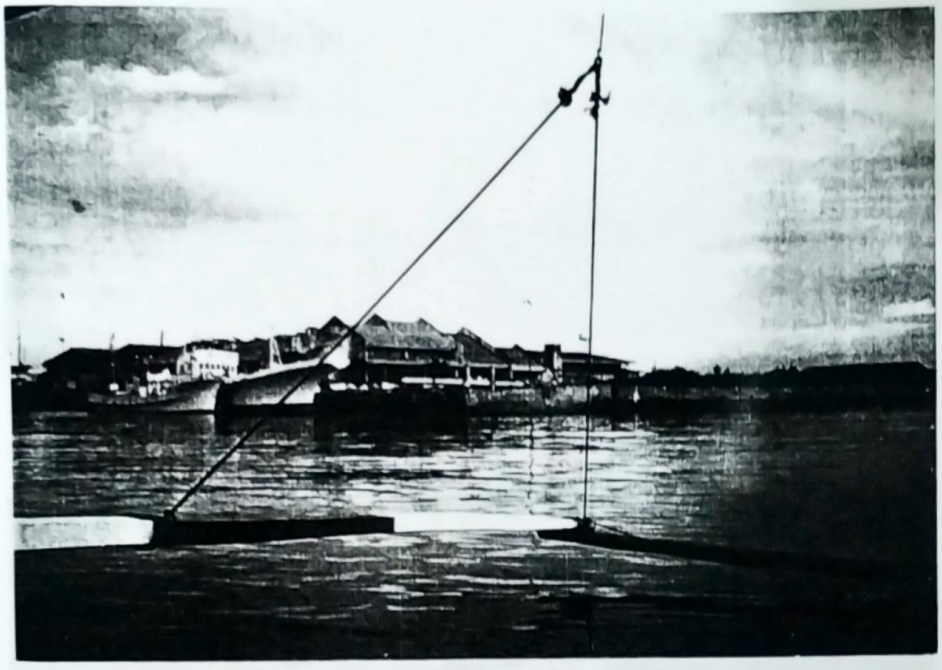

PLATE I — SITE I
NEAR THE FISHING PORT

PLATE 2 SITE 2
BETWEEN THE FISH PORT AND THE NAPOCOR POWER BARGE

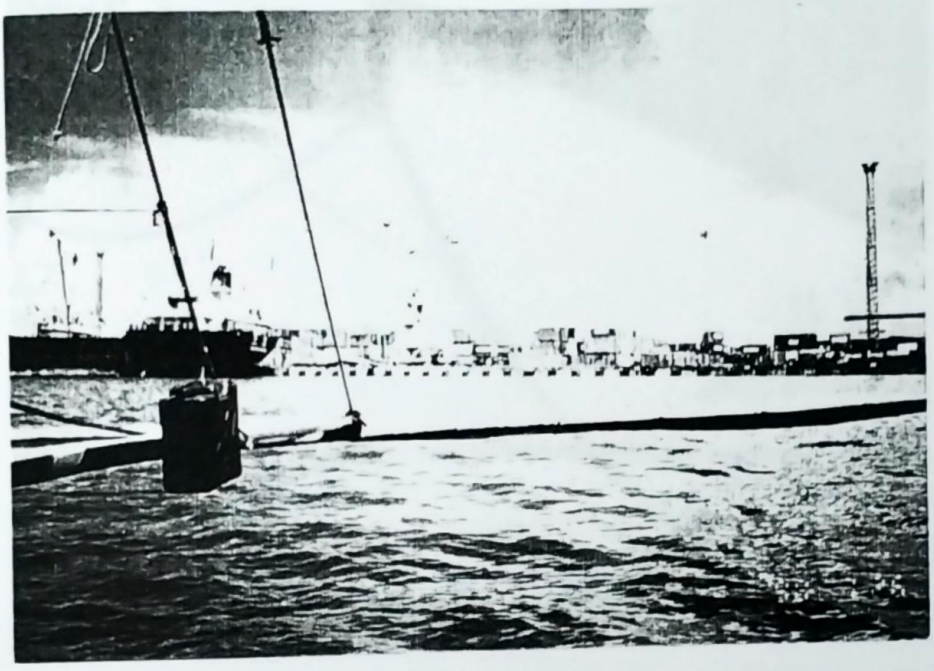

PLATE 3 SITE 3
NEAR THE NAPOCOR POWER BARGE

PLATE 4 SITE 4
BETWEEN THE ILOILO HARBOR AND GUIMARAS ISLAND

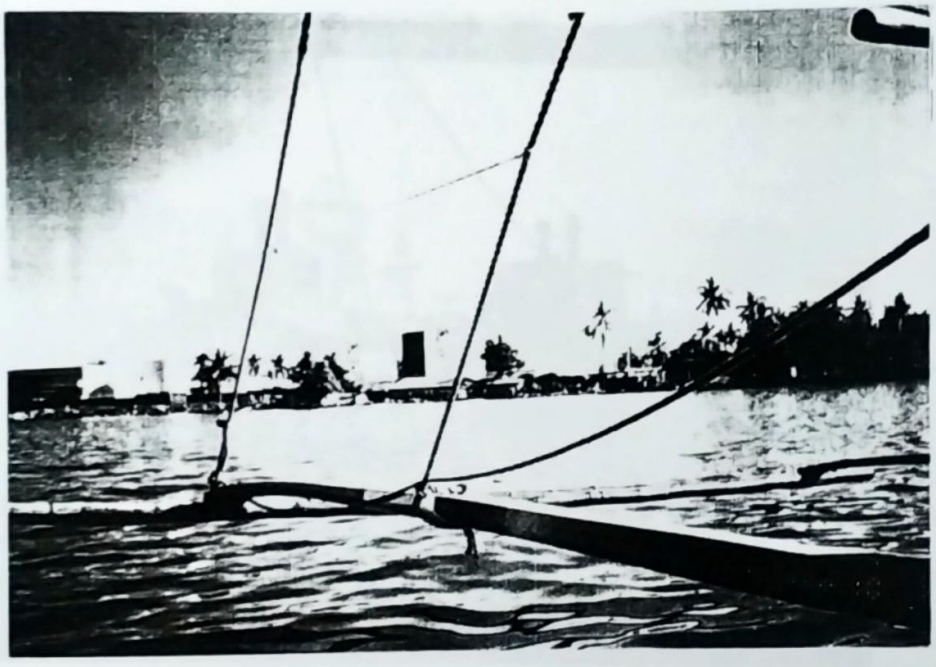

PLATE 5 PETRON FUEL TANK
A POSSIBLE POLLUTANT

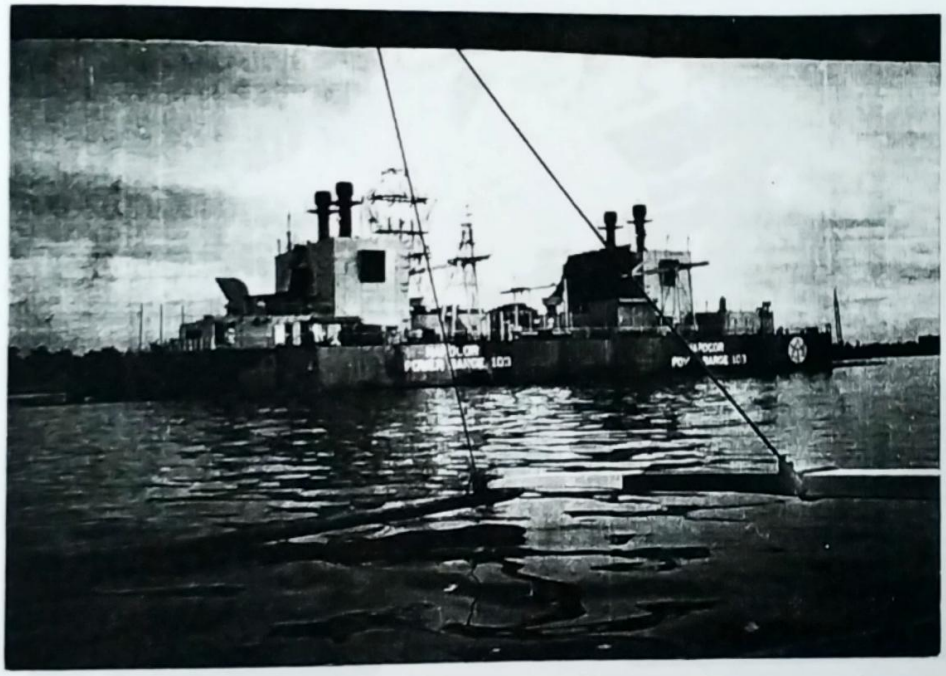

PLATE 6 THE NAPOCOR POWER BARGE
A POSSIBLE POLLUTANT

PLATE 7 COLLECTION OF
WATER SAMPLES

PLATE 8 COLLECTION OF
WATER SAMPLES

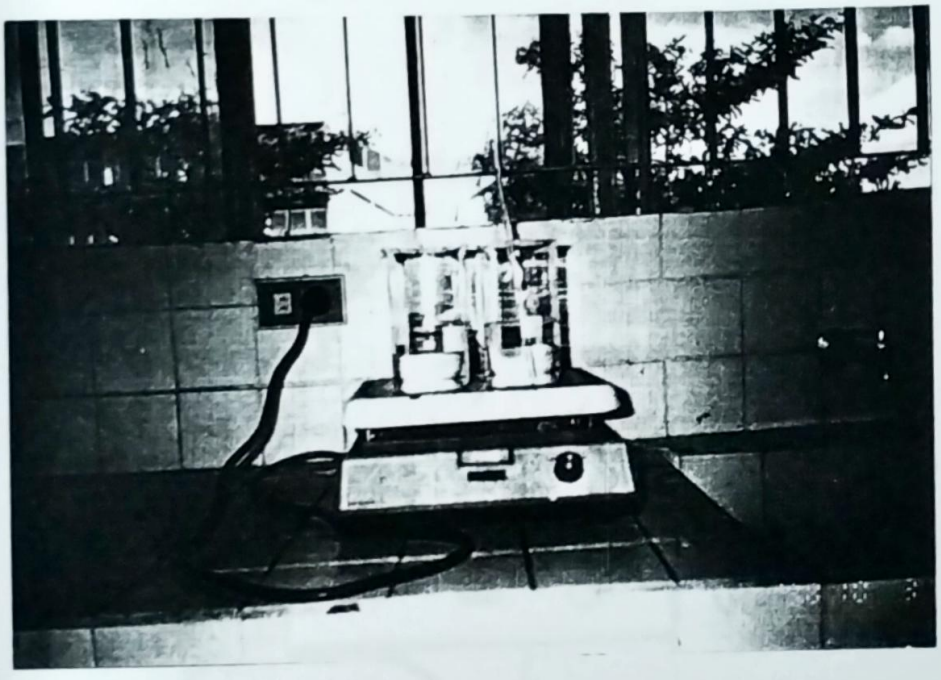

PLATE 9 PREPARATION
OF LACTOSE BROTH

PLATE 10 SET-UP FOR THE
DETERMINATON OF DISSOLVED SOLIDS

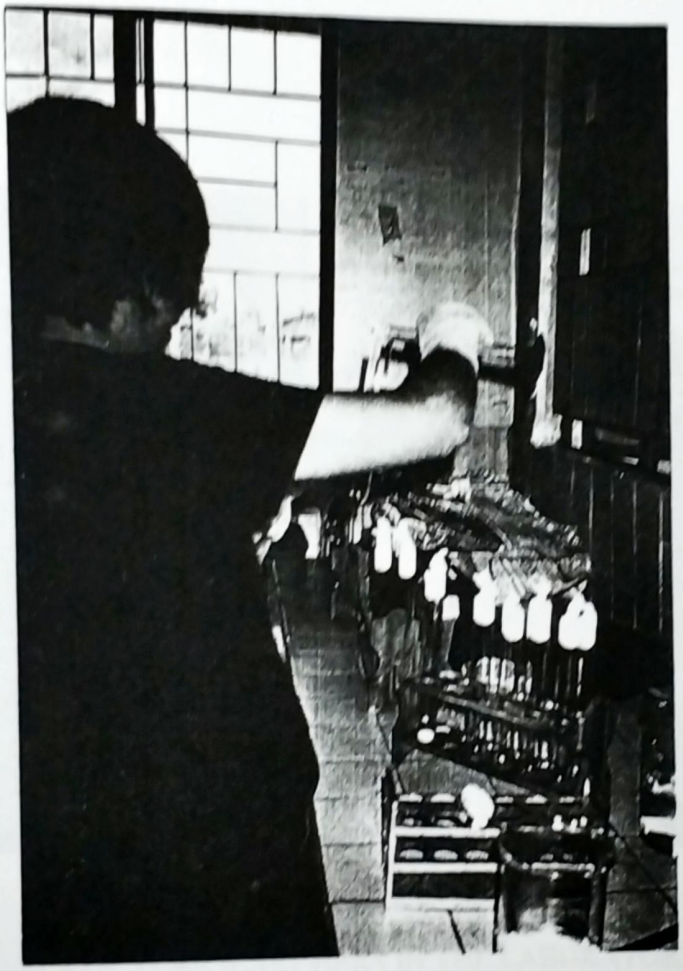

PLATE 10 SET-UP FOR THE
DETERMINATON OF DISSOLVED SOLIDS

PLATE 11 RESEARCHERS IN THE LABORATORY
STRELIZING THE LACTOSE BROTH

PLATE 12 RESEARCHERS IN THE LAB
INCUBATING THE SAMPLES

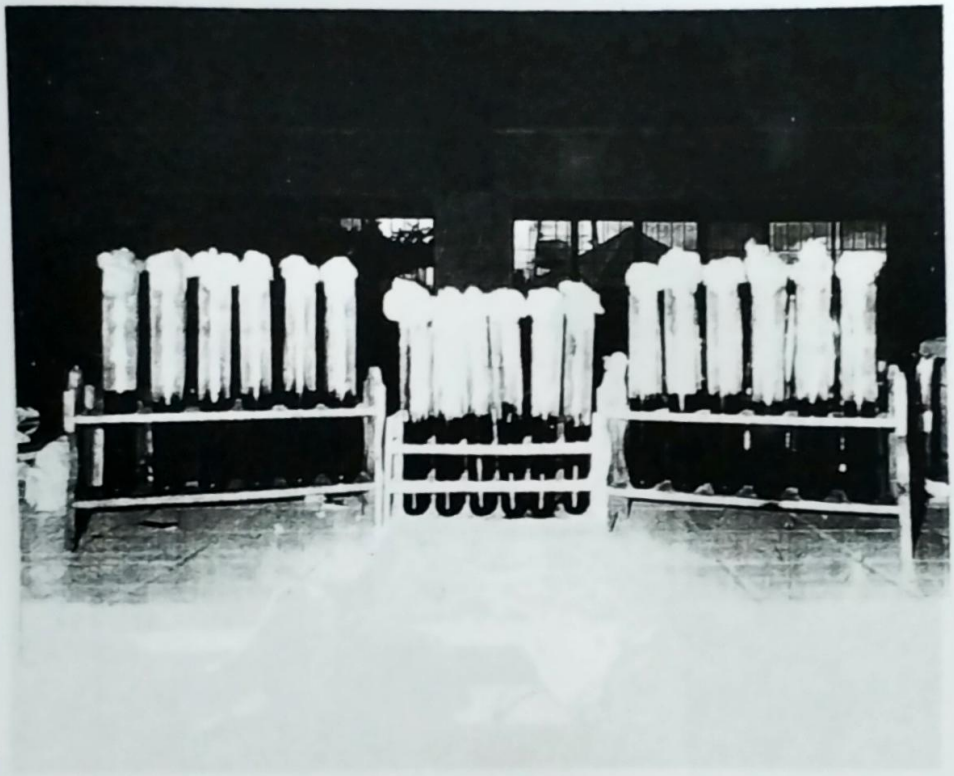

Plate. No. 13
Set-up for the Confirmatory Test using Brilliant green Bile Broth

Plate. No. 14
Researchers in the testing site using various instruments

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TABLE 8
WATER QUALITY OF ILOILO HARBOR. VALUES ARE THE RAW TAKEN ON THE JULY 26,1998 TESTING.

SAMPLING STATION	SALINITY (PPT)	Ph	TEMPERATURE (°C)	DO (PPM)	CONDUCTIVITY (OHMS)
1 REP 1	33.6	7.39	30.9	6.65	51.4
REP 2	33.5	7.30	31.0	6.40	57.1
REP 3	33.4	7.25	31.0	6.44	51.0
2 REP 1	33.2	7.45	30.9	6.38	51.0
REP 2	33.3	7.57	30.9	5.81	51.1
REP 3	33.3	7.57	30.9	5.98	51.1
3 REP 1	33.2	7.50	30.9	5.98	50.9
REP 2	33.2	7.51	30.9	5.69	50.9
REP 3	33.07	7.50	30.97	9.19	52.7
4 REP 1	33.1	7.50	31.0	7.67	54.6
REP 2	33.1	7.52	31.0	8.24	52.37
REP 3	33.1	7.59	31.07	8.66	54.67

TABLE 9
WATER QUALITY OF ILOILO HARBOR. VALUES ARE THE RAW TAKEN ON THE OCT.4, 1998 TESTING.

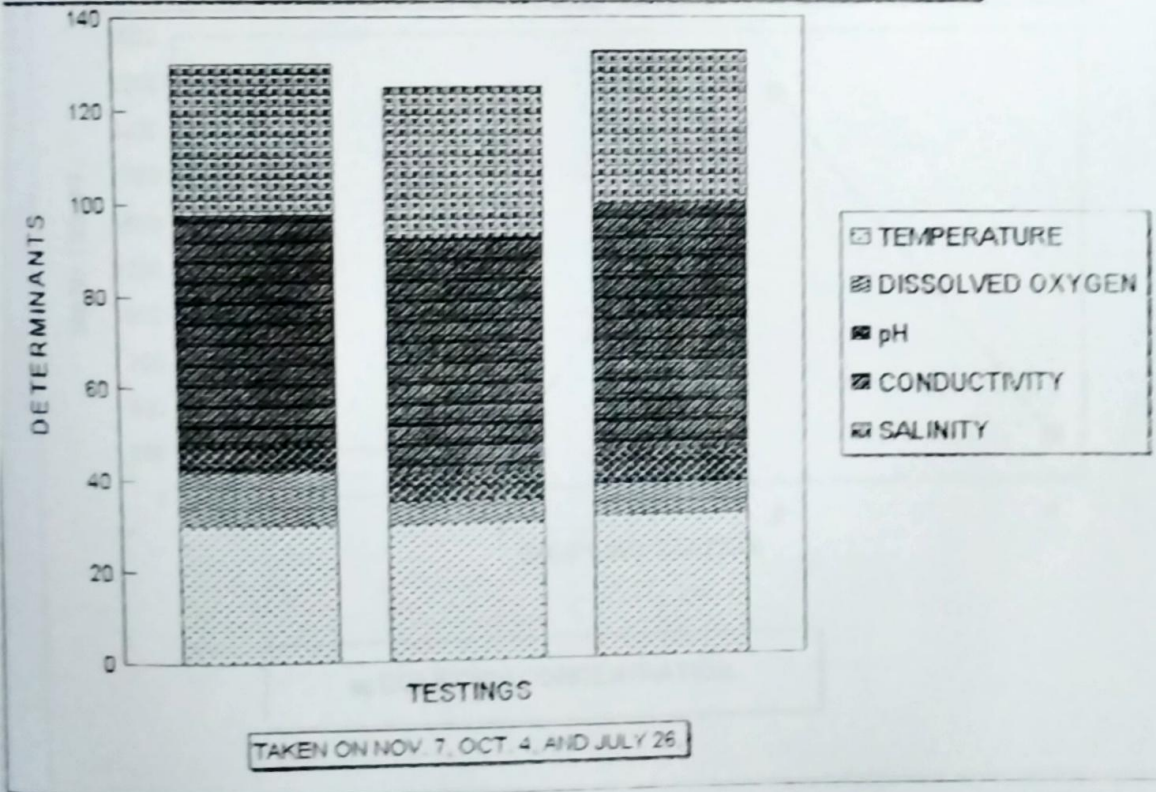
SAMPLING STATION	SALINITY (PPT)	Ph	TEMPERATURE (^{O}C)	DO (PPM)	CONDUCTIVITY (OHMS)
1 REP 1	34.80	6.11	29.70	4.86	50.20
REP 2	30.30	6.13	29.70	4.80	54.80
REP 3	32.80	6.19	29.40	5.31	50.40
2 REP 1	32.90	6.06	29.80	4.87	55.00
REP 2	32.90	6.07	29.80	4.84	50.40
REP 3	32.90	6.03	29.80	4.82	50.40
3 REP 1	32.80	6.13	29.80	4.84	50.30
REP 2	32.80	6.15	29.90	4.80	50.40
REP 3	32.80	6.11	29.90	4.86	50.40
4 REP 1	32.90	6.11	29.80	5.56	50.40
REP 2	32.90	6.14	29.90	5.47	50.40
REP 3	32.90	6.18	30.20	5.80	50.40

TABLE 10
WATER QUALITY OF ILOILO HARBOR. VALUES ARE THE RAW TAKEN ON THE NOV. 7, 1998 TESTING.

SAMPLING STATION	SALINITY (PPT)	Ph	TEMPERATURE (^{o}C)	DO (PPM)	CONDUCTIVITY (OHMS)
1 REP 1	32.30	5.50	29.90	10.60	49.50
REP 2	32.31	5.50	29.90	10.65	49.50
REP 3	32.30	5.50	29.90	10.61	49.50
2 REP 1	32.30	6.00	30.10	10.66	49.50
REP 2	32.25	6.00	30.10	10.65	49.50
REP 3	32.23	6.00	30.10	10.68	49.50
3 REP 1	32.20	7.10	30.00	13.49	49.50
REP 2	32.20	6.98	29.90	11.02	49.50
REP 3	32.20	7.08	29.90	13.46	49.50
4 REP 1	32.20	7.23	30.20	13.69	49.50
REP 2	32.20	7.04	30.10	10.80	49.50
REP 3	32.20	7.04	30.10	13.95	49.50

GRAPH 1.

WATER QUALITY OF ILOILO PORT WATERS



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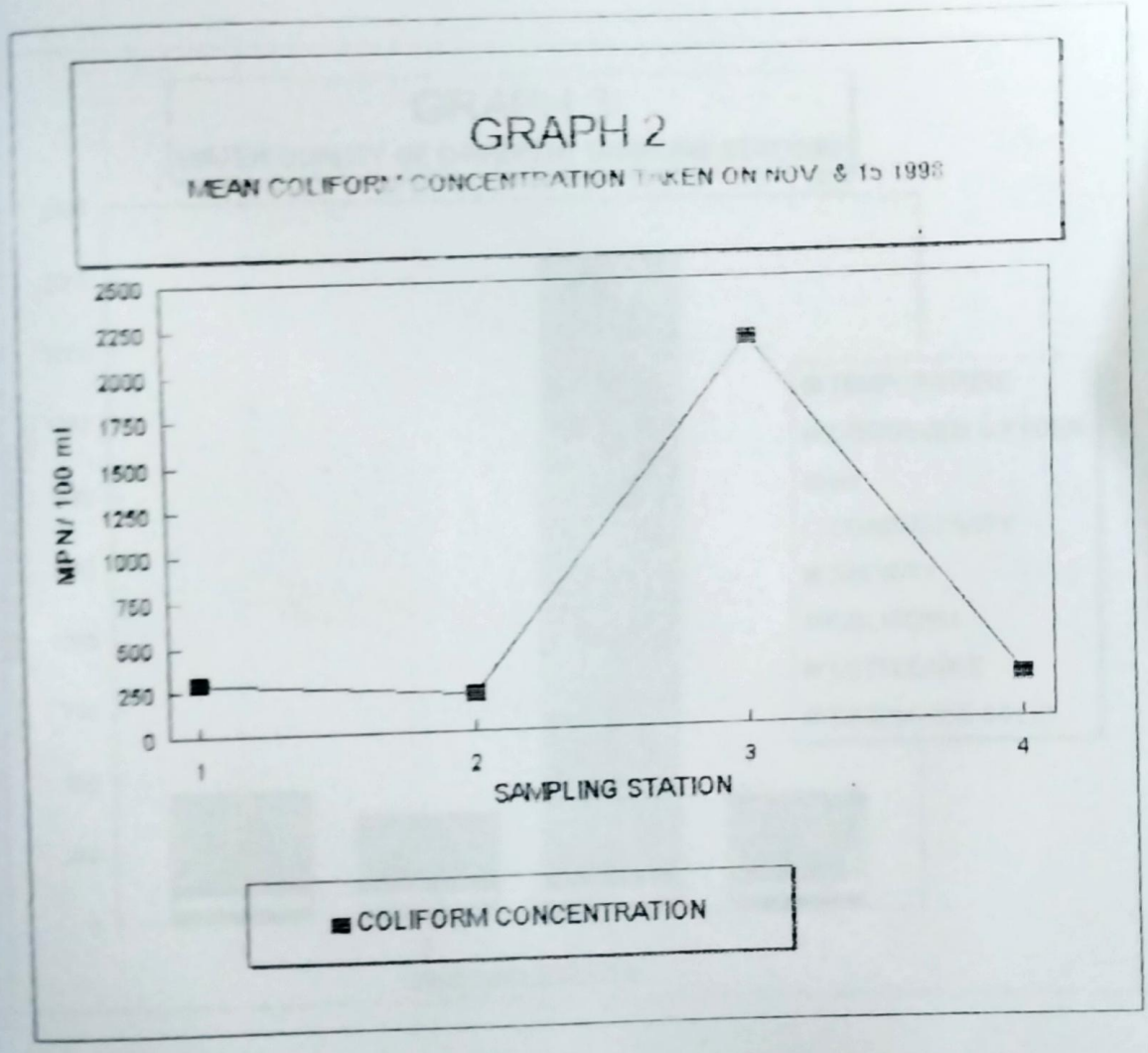
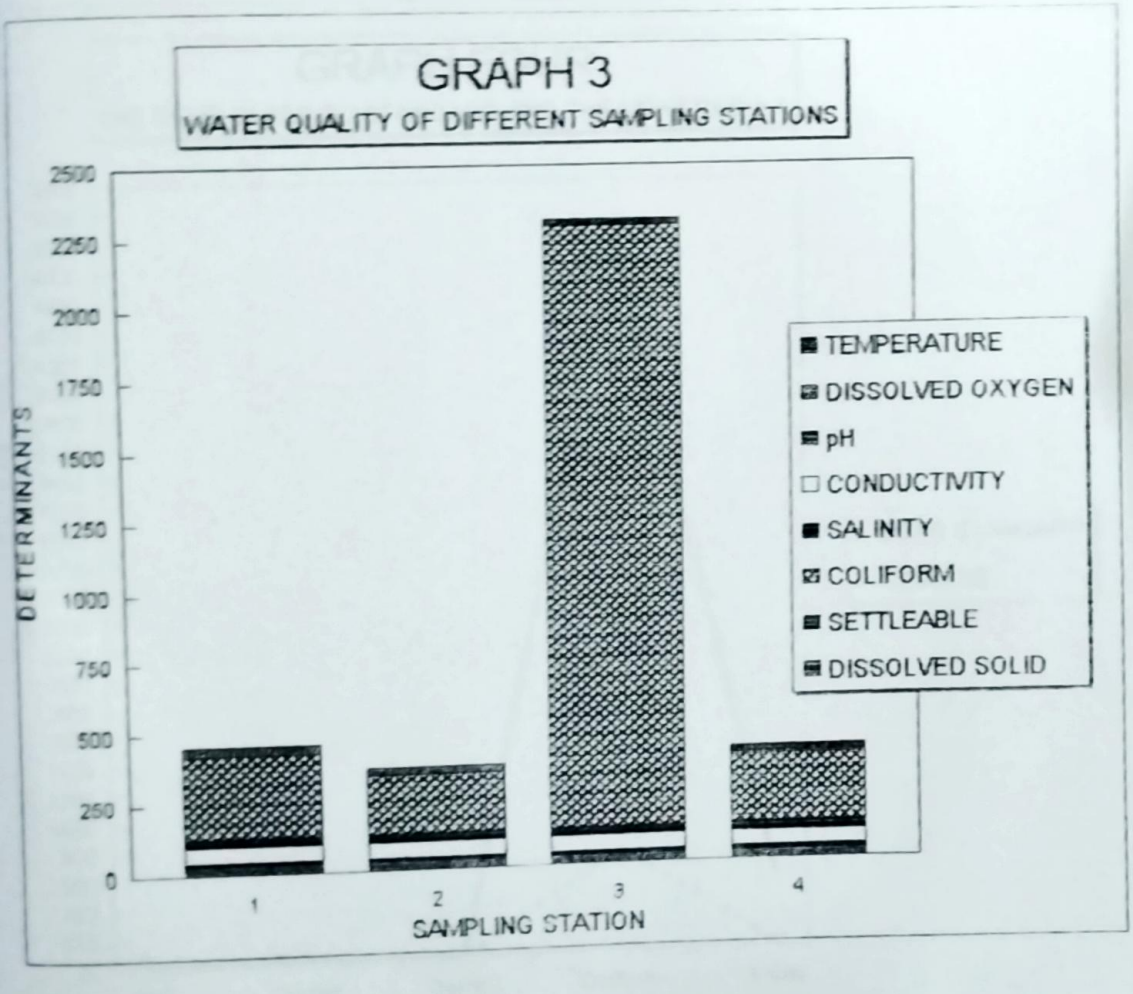

GRAPH 2
MEAN COLIFORM CONCENTRATION TAKEN ON NOV & 15 1998
MPN/ 100 ml
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
1
2
3
4
SAMPLING STATION
COLIFORM CONCENTRATION


GRAPH 3
WATER QUALITY OF DIFFERENT SAMPLING STATIONS
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
DETERMINANTS
1
2
3
4
SAMPLING STATION
TEMPERATURE
DISSOLVED OXYGEN
pH
CONDUCTIVITY
SALINITY
COLIFORM
SETTLEABLE
DISSOLVED SOLID

GRAPH FOUR

THE DENR CLASS SC STANDARD AND THE MEAN RESULT