WATER QUALITY ASSESSMENT OF THE DRINKING WATER OF PHILIPPINE SCIENCE HIGH SCHOOL WESTERN VISAYAS CAMPUS AND BARANGAY BITOON, JARO, ILOILO CITY, ILOILO, PHILIPPINES

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APPROVAL SHEET

This research paper hereto entitled:

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ABSTRACT

This study was conducted with the primary objective of determining the water quality of the drinking water in PSHSWVC and in the residential area of Brgy. Bitoon, Jaro, Iloilo City, Iloilo. Water samples were taken from six (6) different sites: three from PSHSWVC and the remaining three from Brgy. Bitoon, Jaro, Iloilo City. The following determinants were tested at the PSHSWV Science Research Laboratory: pH, filterable solids, dissolved solids, total solids and coliform bacterial concentration.

Results showed that the pH level ranged from 6.65 units to 6.83 units, filterable solids averaged to 0.211 g, dissolved solids averaged to 30290 mg/L, and total solids averaged to 0.881 grams.

For the coliform bacterial determination, the water samples were tested using the Multiple Tube Fermentation Method to determine the presence of the coliform bacteria. This method utilized Lactose broth tubes for the presumptive test and Brilliant Green Bile solution for the confirmative test of each water sample.

Results showed that the average number of positive test tubes ranges from three (3) to five (5) in the

presumptive test and two (2) to four (4) in the confirmative test in all of the six sampling stations.

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Chapter I

Introduction

A. BACKGROUND OF THE STUDY

Water for drinking, cooking, and other domestic uses should be of good quality, which is free from organisms that may cause disease and from chemical substances and radioactive matter that may pose a health risk. The water should be aesthetically appealing, which means that it should free from objectionable color, odor, and taste.

Homeowners should have their water tested to determine its quality. Harmful bacteria or chemicals can be present in drinking water that tastes, looks, and smells acceptable.

In Philippine Science High School Western Visayas Campus, people are banned from drinking the water present in the dormitories, laboratories, and comfort rooms due to a report in year 2000 that it is unsafe from drinking.

Thus realizing the situation, this study was conducted to assess the quality of the drinking water of Philippine Science High School Western Visayas. And due to the fact that the school is situated in Barangay Bitoon, Jaro, Iloilo City, the quality of the drinking water of the residential areas in that barangay was also tested.

This study was done to determine whether the drinking water of PSHS-WVC and Barangay Bitoon passes the standards set by the Department of Environment and Natural Resources (DENR) or not and also to assure the safety of the people residing there.

B. STATEMENT OF THE PROBLEM

In this study, the quality of the drinking water of Philippine Science High School Western Visayas Campus and Barangay Bitoon, Jaro, Iloilo City, Iloilo, Philippines was determined.

C. HYPOTHESIS OF THE STUDY

The quality of the drinking water from the different stations in the PSHS-WVC and Barangay Bitoon varied depending on its location.

D. OBJECTIVES OF THE STUDY

1) This study aimed to determine the water quality of the six (6) different stations in the study site. Three stations were from Philippine Science High School Western Visayas Campus and the remaining three stations were from Barangay Bitoon, Jaro, Iloilo City, Iloilo, Philippines using the following parameters:

a) Water pH

b) Filterable Solids

c) Dissolved Solids

d) Coliform bacterial concentration

2) It also aimed to assess the quality of the drinking water of Philippine Science High School Western Visayas Campus and Barangay Bitoon, Jaro, Iloilo City, Iloilo, Philippines with reference to the standards set by the Department of Environment and Natural resources (DENR).

E. SIGNIFICANCE OF THE STUDY

The research could give benefit to the residents of the study site, and the people who might need information about the drinking water in PSHS-WVC and Barangay Bitoon.

This might also serve best for any future research papers involving water quality.

F. SCOPE AND LIMITATIONS

This study was conducted for the months of July and August 2002, at Philippine Science High School Western Visayas Campus and Barangay Bitoon, Jaro,Iloilo City, Iloilo, Philippines.

The study site was divided into six different stations. Three stations were from PSHS-WVC and the remaining three were from the residential area of Barangay Bitoon.

This study was limited to four determinants only. These determinants include water pH, filterable solids, dissolved solids, and coliform bacterial concentration.

This study was performed during the months of July to October 2002.

B. DEFINITION OF TERMS

BACTERIAL QUALITY

- usually assessed by a coliform test.

COLIFORM BACTERIA

- preferred indicator of the contamination of water and possible presence of intestinal parasites and pathogens.

CONTAMINATED WATER

- water containing either poisonous chemical or pathogenic organism, yet still is clean and clear to see.

DISSOLVED OXYGEN

- the amount of oxygen present that increases the palatability of water especially measured by a dissolved oxygen meter.

DRINKING WATER

- water used for drinking and cooking.

pH

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

WATER POLLUTANTS

- any various noxious chemicals and refuse materials which contributed to the impurity of water.

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 process of aquatic systems.

WATER QUALITY

- determined by the amount of substances found in water; the suitability of water for aquatic life and for human use depends on its quality.

CHAPTER II

REVIEW OF RELATED LITERATURE

A. WATER

Our Earth seems to be unique among the other known celestial bodies. It has water, which covers three-fourths (3/4) of its surface and constitutes 60-70 weight percent of the living world. Only 1% of the world's water is usable to us. About 97% of the world's water is salty sea water, and 2% is frozen in glaciers and polar ice caps. Thus that 1% of the world's water supply is a precious commodity necessary for survival. Dehydration (lack of water) will kill us faster than starvation (lack of food). Since the plants and animals we eat also depend on water, lack of it could cause both dehydration and starvation. The scenario gets worse. Water that looks drinkable can contain harmful elements, which could cause illness and death if ingested (www.cotf.edu/nodules/waterq/wqwaterimport.html, 2001).

B. WATER POLLUTION

Water pollution involves the release into bodies of water of substance that become dissolved or suspended in the water or deposited upon the bottom to accumulate to the extent that they interfere with the processes of aquatic systems (Encyclopedia Britannica, 1993). It is one of the most serious environmental problems of today's society. It occurs when such substances as human and animal wastes, toxic chemicals, metals, and ions contaminate water. Pollution can affect rain, rivers, lakes, and oceans, and the water beneath the surface of the earth called the ground water (Flores, et al. 1999).

The most common physical contaminant of water is suspended sediment. Other physical contaminants include organic materials such as plant residues. Most sediment occurs because of soil erosion; however, sand may be obtained during the pumping from wells (Apolonio, et al., 1997).

Metals, minerals and other inorganic and organic substances can alter the pH and osmotic pressure of water, and some are toxic to humans and other organisms. Synthetic chemicals can persist in water because most decomposers lack enzymes to degrade them. Oil is another water pollutant. Radioactive substances released into water persist as a hazard to living organisms until they have undergone natural radioactive decay (Flores, et al., 1999).

The most common sources of water pollution are chemical wastes, raw sewage, and high temperatures. Toxic chemicals can pollute water supplies in two ways. The chemicals can enter streams and rivers, which carry them first into lakes and then into oceans. There the toxic chemicals can kill aquatic plants and animals or they can enter the food chain and eventually pose a threat to human health. Even in lakes as large as the Great Lakes, the presence of several pollutants has made eating fishes from these waters dangerous to health. In addition, chemical wastes discarded on land can seep through the ground and enter the underground water supply, through which they can be carried long distance. Toxic chemicals contaminate wells and the underground water supplies that serve many towns and cities. Because water moves through the ground slowly, toxic chemicals in underground water are difficult to remove (Miller, 1995).

Domestic wastes are usually not poisonous to life as are chemical pollutants, but they do pose environmental problems. Sewage consists of large quantities of water contain nitrogen compounds. These compounds are used by bacteria in a process that requires oxygen. If untreated sewage is added to rivers and streams, the number of bacteria increases dramatically. These bacteria use up most of the available oxygen as they break down the nitrogen compounds. Other organisms that live in the water may suffocate because their supply of oxygen is depleted (Miller, 1995).

C. WATER QUALITY

Water quality is determined by the concentration of biological, chemical, and physical contaminants. Most water pollution is the result of human activities. Biological contaminants result from human and animal wastes plus some industrial processes. Chemicals enter the water supply from industrial processes and agricultural use of fertilizers and pesticides. Physical contaminants result from erosion and disposal of solid waste (Apolonio, et al., 1997). It is important in an aquatic ecosystem. Factors affecting water quality play vital role in the life of organisms. These factors serve as parameters in determining what type of organisms may or may not thrive in an ecosystem (Estilo, et al., 1998).

D.1 WATER pH

The pH of a liquid is the negative logarithm of the concentration of hydrogen ions in the solution. Because water pH scale is logarithmic, every single unit change in pH actually represents a ten fold change in acidity. For instance, at pH 7 there are 1 x 10^{-7} hydrogen ions, at pH 6 there are 1 x 10^{-6} hydrogen ions present (www.cotf.edu/nodules/waterq/ wqwaterimport.html, 2001).

The pH of water is a measure of acidity or alkalinity. It is an important quality factor. It is a log-base 10 scale that measures acidity of a solution on a scale of 0 to 14. The pH of neutral solutions, such as pure water is equal to seven (7). Alkaline solutions will have high pH (8-14) and acidic solutions will have low pH (1-6)

The pH of water is controlled by the equilibrium achieved by dissolved compounds in the system. In natural water, the pH is primarily a function of the carbonate system (AWWA, 1990, ERA, 1986).

D.2 DISSOLVED OXYGEN

Low dissolved oxygen indicates on the oxygen demand the oxygen of the system. Build up of organic material from human activities is one source of oxygen depletion. Microorganisms in the stream consume oxygen as they decompose inadequately treated sewage, urban and agricultural runoff, and discharge from food-purchasing plants, meat-packaging plants, and dairies that has entered the stream.

One measure of dissolved oxygen in water is parts per million (ppm), which is the number of molecules, per million total molecules in a sample. Calculating the percent saturation is another way to analyze dissolved oxygen levels. Percent saturation is the measured dissolved oxygen level divided by the greatest amount of oxygen that the water can hold under various temperature and atmospheric pressure conditions multiplied by 100 (www.cotf.edu/nodules/waterq/wqwaterimport.html, 2001).

Dissolved oxygen analysis of surface water provides an important basis on the biological and biochemical reactions going on in the natural waters. The amount of dissolved oxygen directly affects aquatic life especially those dependent on aerobic respiration reactions for energy production needed for growth and reproduction. The amount of dissolved oxygen in the natural waters also determines the capacity of water to receive waste without killing aquatic life (Apolonio, et al., 1997).

Microorganisms depend on the amount of dissolved oxygen in water for their aerobic respiration. A marked decrease of dissolved oxygen because of bacterial decay of organic wastes had been a major impact of water pollution (Apolonio, et al., 1997).

D.3 FILTERABLE SOLIDS

Total filterable solids are the amount of suspended solids in a water sample. They remain in the filter paper after filtration and are measured in mg/l of sample of water (http://bfhd.wa.gov/terms/infoTSS.html, 2002).

TFS is produced whenever sediment leaves the land surface and is carried by water into streams and lakes. This occurs wherever the surface of the soil is exposed to rainfall and runoff (water flowing over the surface) that is not interrupted by plant roots and stems, a low slope area, or other area where the sediments are deposited before reaching the water (http://www.osc.edu/education/waebed/projects/real_data/tss.shtml, 2002).

D.4 DISSOLVED SOLIDS

Total dissolved solids (TDS) can have an important effect on the taste of drinking water. The palatability of water with a TDS level of less than 600 mg/litre is generally considered to be good; drinking water becomes increasingly unpalatable at TDS levels greater than 1200 mg/litre. Water with extremely low concentrations of TDS may be unacceptable because of its flat, insipid taste (http://www.who.int/water_sanitation_health/GDWQ/acceptability.htm#Total dissolved solids, 2002).

TDS is that portion of solids in water that can pass through a 2 micron filter. The more minerals dissolved into the water the higher the total dissolved solids. Waters with high dissolved solids are generally of inferior palatability. In drinking water a limit of 500 mg/L is desirable (http://www.bfhd.wa.gov/terms/infoTSS.html,2002).

The presence of high levels of TDS may also be objectionable to consumers owing to excessive scaling in water pipes, heaters, boilers, and household appliances. Water with concentrations of TDS below 1000 mg/litre is usually acceptable to consumers, although acceptability may vary according to local circumstances (http://www.who.int/water_sanitation_health/GDWQ/acceptability.htm#Totaldissolved solids, 2002).

D.5 COLIFORM BACTERIA AND WATER

The coliform bacteria, which include *E. coli*, are gram-negative, nonspore-forming, aerobic, or facultative anaerobic bacteria that ferment lactose and produce acid and gas. Most municipal water supplies are regularly tested for the presence of coliform bacteria. The presence of any significant number of coliform may not be safe for drinking (Black, 1993).

Eschirichia coli is called an indicator organism because it is a natural inhabitant of that human intestinal tract, and its presence in water indicates that the water is contaminated with fecal material (Black, 1993).

Since 1880, coliform bacteria have been used to assess the quality of water and the pathogens being present. Although several of the coliform bacteria are not pathogenic themselves, they serve as an indicator of potential bacterial pathogen contamination. It is generally much simpler, quicker, and safer to analyze for that organisms than for the individual pathogens that may be present (Flores, et al., 1999).

Recommended fecal coliform bacteria counts are: (a) drinking water less than colonies per 100 ml sample of water, (b) swimming less than 200 colonies per 100 ml sample of water, and (c) boating/ fishing ;less than 1000 colonies per 100 ml sample of water (http:k12science.ati.stevenstach.edu/curriculum/ waterproj/bacteria.html,2002).

D.6 THE MULTIPLE TUBE FERMENTATION METHOD

The Multiple Tube Fermentation Method involves three stages of testing. These are the presumptive test, the confirmative test, and the completed test. In the presumptive test, a water sample is used to inoculate the lactose broth tubes. The tubes are incubated at 35°C and observed after 24 hours and 48 hours for evidence of gas production. Gas production provides presumptive evidence that coliform bacteria are present. Because certain noncoliform bacteria also produce gas, additional testing is necessary to confirm the presence of coliforms. In the confirmative test, samples from the highest dilution showing gas production are streaked into eosin-mythelene blue (EMB) agar plates. Thus, after a 24-hr incubation, coliform colonies have dark centers and may also have metallic greenish sheer. Observing such colonies confirms the presence of coliforms. In the completed test, organisms from dark colonies are used to inoculate broth and agar slants. The production of acid and gas in the lactose broth and microscopic identification of gram-negative, nonspore-forming rods from slants constitute a positive completed test (Black, 1993).

E. DENR'S STANDARD

The quality of the water for natural bodies of water used for swimming, bathing or other contact recreation purposes shall be within the standard set by the Department of Environment and Natural Resources (DENR).

A) Inland Waters. For Inland water, total coliform shall not exceed 1,000 MPN/100-mL of water sample, and a pH range of 6.5 - 8.5.

B) Marine and Estuaries Waters. For marine water, total coliform shall not exceed 1,000 MPN/100-mL of water sample, fecal coliform shall not exceed 200 MPN/100-mL of water sample, and pH range of 6.0 - 8.5 (Environmental Health Service, 1998).

F. GENERAL PROVISIONS ON WATER CLASSIFICATION

1) Classification of a water body according to a particular designated use or uses does not prelude use of the water for other purposes that are lower in classification provided that such use does not prelude the quality required for such waters.

2) Water classification are arranged in the order of the degree required, with Class AA and SA having generally the most stringent water quality, respectively, for fresh surface water and marine/coastal waters, and Class D and SD waters have the least stringent water quality for fresh waters and marine waters respectively.

3) The main objective of the water quality criteria is to maintain the minimum conditions necessary to

assure the suitability of water for its designated use or classification

4) Any person regulated under these rules or having a substantial interest in this chapter may reclassification of waters by filing petition with the DENR giving all necessary information to support the petition.

5) All reclassification of water shall be adopted, only after public notice and hearing, and upon affirmative findings by the DENR Regional Office concerned that

   (a) such as reclassification is clearly in the public and

   (b) the proposed designated use is attainable upon consideration and environmental, technological, social, economic, and institutional factors.

Chapter III

Methodology

A. MATERIALS

* pH meter
* hot plate
* 10 beakers
* 3 funnels
* 3 evaporating dishes
* 5 Erlenmeyer's flasks
* autoclave
* triple beam balance
* 24 test tubes
* 2 crucible tongs
* 3 stirring rods
* 2 test tube holder
* 3 filter papers
* oven

B. STUDY AREA AND SAMPLING SITES

The study area were Philippine Science High School Western Visayas Campus and Barangay Bitoon, Jaro, Iloilo City, Iloilo. Six sampling stations was chosen. Three stations were from PSHS-WVC: (1) Boys' Residence Hall (2) School Canteen (3) Girls' Residence Hall . The remaining three stations were randomly selected from the residential site of Barangay Bitoon: Bitoon Site #1 - Near Surf, Bitoon Site #2 - far next to B.Site#1 and Bitoon Site #3 - near a red house.

C. WATER COLLECTION

Three water samples were collected from each sampling sites. They were placed in empty sterile plastic bottles and were transported to the PSHS-WVC Research laboratory for testing.

C.1 pH DETERMINATION

The pH meter was used to determine the pH units of the water samples. 10-mL of water sample from each station was transferred to a beaker. The probe of the pH meter was cleaned using distilled water. The probe was wiped using paper towel. It was then dipped in the beaker containing the water sample. The reading was recorded. This was done three times for accuracy.

C.3 FILTERABLE SOLIDS

The filter paper was oven dried and was allowed to cool down. The initial weight of the filter papers was recorded. 250 mL of water sample from each station was filtered using the oven-dried filter papers, funnels and Erlenmeyer's flasks. Again, the filter papers were oven-dried. The filter papers were allowed to cool down. The filter papers were weighed for the final weight. The percent of filterable solids was determined by subtracting the initial weight from the final weight over the final weight times 100.

C.4 DISSOLVED SOLIDS

The initial weight of the tared evaporating dishes was recorded. From the filtered 250 mL water samples, 20 mL was placed in the evaporating dishes. The evaporating dishes were placed on the hot plate. The evaporating dishes were removed from the hot plate, with the help of the crucible tongs, after the water has evaporated. The evaporating dishes were allowed to cool down in a dessicator. The final weight of the evaporating dishes was recorded.

C.5 TOTAL SOLIDS

The filterable solids and the dissolved solids of each water sample were added. The sum was recorded.

D. COLIFORM CONCENTRATION LEVEL DETERMINATION

1.1 Sterilization of Apparatus

Materials:

* autoclave
* paper
* fermentation tubes with cotton plugs
* pippetes
* funnels
* oven
* hot plate

* dilution bottles * stirring rod
* beakers * test tubes

Procedures:

Glasswares were thoroughly washed, then oven-dried for 30 minutes, and were wrapped in paper. Glasswares were then positioned inside the autoclave. Autoclave was sealed. The autoclave was allowed to operate for 20 minutes and then was turned off. Autoclave was cooled before apparatus were taken out.

1.2 Preparation of Lactose Broth

Materials:

* distilled water * hot plate
* stirring rods * 2000- mL beaker
* balance beam * autoclave
* DIFCO Lactose Broth Powder
*test tubes with Durham tubes
* graduated cylinder * alcohol lamp
* cotton plugs

Procedures:

The lactose broth powder was weighed; 13 grams per 1 Liter of water. It was mixed with designated amount of water. The mixture was stirred on the hot plate until the powder totally dissolved. The solution was allowed to cool down. Then 10 mL was rationed per test tubes using a graduated cylinder over the flame. It was sealed with cotton plugs. Then it was put in the autoclave.

1.3 Preparation of Dilution Bottles

Materials:

* 100-mL prescription bottles
* phosphate buffer
* distilled water

Procedures:

Sterilized the bottles in the autoclave. 1.25 mL of phosphate buffer was mixed with 1000 mL of water. Each bottle was filled with 100-mL of the solution. Bottles were tightly sealed. There were six bottles for each sampling site and they were labeled.

1.4 Preparation of Dilution Water

Materials:

* Dilution water bottles
* Alcohol lamp
* Pipette

Procedures:

One by one the dilution water bottle was uncapped, the mouth of which was sterilized over the flame. 11- mL of pure water sample was pipetted into the dilution water. The mouth of the cap of the dilution bottle was sterilized before the cover was returned. The sample was shook at least 10 times. The same procedure was used to the remaining dilution water bottles.

1.5 Inoculation process for Pure Water Sample

Materials:

* pure water sample

* Lactose containing test tubes

* pipette * alcohol lamp

Procedures:

Pure water sample bottles of sampling site #1 were shook at least 30 times. The cover of each was removed one after the other. 1-mL of pure water sample was pipetted to its corresponding test tubes containing lactose media. Test tubes with sample were shaken. Test tubes were then put in the autoclave for sterilization The test tubes were heated for 20 minutes. After the test tubes have been cooled, they were left inside the laboratory at room temperature. The same was done to the remaining pure water sample bottles.

1.6 Inoculation of Dilution Bottles

Materials:

* dilution water bottles * alcohol lamp
* Lactose containing tubes

Procedures:

The lactose containing test tubes were labeled. The cap of dilution water bottle was removed and the mouth of which was sterilized over the flame. The pipette was washed with distilled water and sterilized over the flame. The stopper of lactose media was removed and the mouth of the test tube was sterilized. 10 mL of dilution water 'sample was added to the lactose media. The mouth of the cap and stopper of the test tubes were sterilized over the flame. The test tube with sample was shook and was placed inside the test tube rack at room temperature for 24 hrs. After 24 hrs, the test tubes were checked for gas formation. The same were done to the remaining dilution water bottles and lactose-containing test tubes.

1.7 Preparation of Brilliant Green Bile

Materials:

* Brilliant Green Bile Powder * Beaker

* hot plate
* distilled water
* test tubes with Durham tubes
* stirring rod
* balance beam
* autoclave

Procedures:

40 grams of BGB Powder was weighed for every liter of water. The powder was mixed with water in a beaker. The mixture was stirred over a hot plate until the powder dissolved. 10 mL of the solution was rationed per test tube. The test tubes were then sterilized in the autoclave.

1.8 Inoculation of BGB

Note: Only to be performed if Lactose Media showed gas formation.

Procedures:

The lactose media containing tube was shaken to unsettle the bacteria. The loop was sterilized until it glows red. The cap of the test tube was removed and its mouth was sterilized. The cap of the BGB containing tube was removed and its mouth was sterilized. The red wire loop was dipped in the lactose media and was transferred to the BGB containing tube, the process was repeated 5 times. The cup was returned. BGB containing tube was shook and was placed in the autoclave for sterilization. It was left at room temperature for gas formation. The test tubes were checked after 48 hrs. The same were done to the other positively tested lactose containing tube.

1.9 Calculating for MPN (Most Probable Number)

The results were summarized. Then necessary figures were substituted to the equation:

$$\frac{\text{MPN}}{\text{100 mL}} = \frac{\text{MPN value (from table) * 10}}{\text{largest volume tested}}$$

Chapter IV

RESULTS AND DISCUSSIONS

The study was aimed to get the water quality of the drinking water of Philippine Science High School Western Visayas Campus and Brgy. Bitoon, Jaro, Iloilo City.

We conducted the experiment for the months of July to November 2002.

For the first months we gathered water samples for the six sampling stations. These water samples were tested for its pH value, filterable solids and dissolved solids. After doing so, we tabulated the results and recorded our observations in our logbook.

For the month of October, we collected water samples from the six different sampling stations. The gathered samples were tested for the coliform concentration level determination. We were able to perform the experiment well, but along the process, we discovered that what we did was partly wrong. We were not able to check the results for the assigned time. We had to repeat our experiment. Again, we gathered water samples and successfully we were able to perform it well. But, we faced another problem. The school did not have any available phosphate buffer for us to use. We researched for an alternative.

After the one-week break for the month of November, we proceeded to our experimentation. We requested for the chemicals that we needed to come up with the phosphate buffer solution. We also gathered water samples from the six different sampling stations. We somehow effectively come up with our results.

We tabulated the results of each parameter from the six different sampling stations. The tables are in Appendix C.

The over-all pH value that we got ranges from 6.65 to 6.83 units. The over-all percentage for the filterable solids from each water sample is 21.1%. The over-all dissolved solids averages to 30290 mg/L per sample. Though the results showed different results from different sampling sites. Finally, the over-all value for the total solids per sample is equal to 0.881 grams.

For the coliform concentration level determination, we were able to acquire results. These results vary or are different from each other with respect to the sampling site.

According to our data, the COOP, GRH and Bitoon Site #2 showed the highest MPN for the presumptive test (pure water) while the BRH showed the lowest result. For the confirmative test of the pure water, the COOP and Bitoon Site #1 ranked first as Bitoon Site #3 and BRH ranked last.

Concerning about the test on dilution water samples, we were also able to acquire results that varies. The presumptive test confirmed that Bitoon Site #1 ranked first while COOP ranked last. In our confirmative test, still Bitoon Site #1 ranked first while COOP ranked last.

After analyzing the data and results, we proceeded into typing our observations and doing the final draft of our research project.

Table 1: Average Physico-Chemical Characteristics of the Six Sampling Stations of Philippine Science High School Western Visayas Campus and Brgy. Bitoon, Jaro, Iloilo City, Iloilo, Philippines during the First Sampling, Second Sampling, and Third Sampling.

Parameters	pH (units)	Filterable Solids (grams/L)	Dissolved Solids (grams/L)	Total Solids (grams/L)
BRH	6.83-6.97	.5904	7.5424	8.1328
COOP	6.23-6.5	.764	8.204	8.968
GRH	6.69-6.9	.784	.8164	1.6004
BITOON SITE #1	6.86-6.89	1.704	1.7164	3.4204
BITOON SITE #2	6.49-6.66	2.708	2.7764	5.4844
BITOON SITE #3	6.82-7.07	.536	0.034	0.57

Table 2: Average Results of the Coliform Concentration Level Determination through finding the Most Probable Number (MPN) of the Six Sampling Stations of Philippine Science High School - Western Visayas Campus and Brgy. Bitoon, Jaro, Iloilo City, Iloilo, Philippines during the First Sampling, Second Sampling, and Third Sampling.

Coliform Level Determination	Pure Water (Presumptive Test) --MPN--	Pure Water (Confirmative Test) --MPN--	Dilution Water (Presumptive Test) --MPN--	Dilution Water (Confirmative Test) --MPN--
BRH	0.85	0.85	1.533	1.533
COOP	3.033	2.6	0.85	0.36
GRH	3.033	1.533	2.6	1.533
BITOON SITE #1	2.6	2.6	2.6	3.033
BITOON SITE #2	3.033	1.533	1.533	1.533
BITOON SITE #3	1.533	0.85	2.36	0.85

CHAPTER V

SUMMARY, CONCLUSIONS AND RECOMMENDATIONS

A. Summary of Significant Findings

In the course of our study, we found out that based on the properties and descriptions found in Appendix A, the water quality of the drinking waters in Philippine Science High School - Western Visayas Campus and Brgy. Bitoon, Jaro, Iloilo City, Iloilo falls under Class A of the Department of Environment and Natural Resources (DENR) Administrative Order No. 24.

The drinking waters of Philippine Science High School Western Visayas Campus and Brgy. Bitoon, Jaro, Iloilo City, Iloilo are slightly acidic with pH ranging from 6.65-6.83 units. We also found out that the over-all percentage for the filterable solids from each water sample is 21.1% while the over-all dissolved solids averages to 30290 mg/L per sample (but taking note that from the six different sampling sites, all of them showed different results). We ended having the result of the total solids per sample is equal to 0.881 grams.

With regard to the coliform concentration level determination, we came up with the following outcome:

(1) The COOP, GRH and Bitoon Site #2 showed the highest MPN for the presumptive test (pure water) while the BRH showed the lowest result.

(2) The COOP and Bitoon Site #1 showed the highest MPN for the confirmative test of the pure water while Bitoon Site #3 and BRH ranked last.

(3) The Bitoon Site #1 ranked first for the presumptive test on dilution water samples while the COOP ranked last.

(4) The Bitoon Site #1 ranked first while COOP ranked last in the confirmative test on dilution water samples.

B. Conclusions

Through proper research and investigation, the researchers found out that the waters have passed the DENR standards and are safe for drinking with respect to the following parameters: pH value and filterable solids.

Concerning with the results acquired from the dissolved solids, since we found out that some sampling stations failed to pass, some stations are not safe. These sampling stations are the BRH and COOP. We also suggest that the drinking waters from the GRH and Bitoon #2 is not to be drunk because it showed results near to the maximum point of safetiness with respect to dissolved solids.

With respect to the coliform concentration level determination, we tried to analyze our data and suggested that since the average number of positive test tubes ranges from three (3) to five (5) in the presumptive test and two (2) to four (4) in the confirmative test in all of the six sampling stations, we concluded that the drinking waters of the six sampling stations are not safe for drinking.

Our conclusion regarding the results from the coliform test was not that precise because we believed that we could have able to acquire specified and well-defined results if hi-tech and modernized apparatus were available.

C. Recommendations

The researchers recommend that further studies be conducted on the water quality of the drinking water in Philippine Science High School - Western Visayas Campus and the residential area of Brgy. Bitoon, Jaro, Iloilo City, Iloilo for the benefit of the people residing in those areas.

It would be effective for future researchers to add more parameters and sampling sites for better water quality analysis. It would also be useful to the future researchers that will be conducting a coliform concentration level determination test on water samples if they will be using hi-technology apparatus or updated materials to come up with a more specified, accurate and well-defined outcomes.

APPENDICES

A.

DEPARTMENT OF ENVIRINMENTAND NATURAL RESOURCES

DENR ADMINISTRATIVE ORDER NO. 24

SERIES OF 1990

SUBJECT: REVISED WATER USAGE AND CLASSIFICATION/ WATER QUALITY CRITERIA AMENDING SECTION NOS. 68 AND 69, CHAPTER III OF THE 1975 NPCC RULES AND REGULATIONS

Section 68: Water Usage and Classification. The quality of Philippine waters shall be maintained in a sage and satisfactory condition to their best usage. For this purpose, all waters shall be classified according to the following beneficial usages:

(a) Fish Surface Waters (rivers/ lakes/ reservoirs, etc.)

Classification	Beneficial Use
Class AA	Public Water Supply Class I. This class is intended primarily for waters having water-sheds which are uninhabited and otherwise protected and which require only approved disinfections in

order to meet the National Standard for Drinking Water (NSDW) of the Philippines.

Class A Public Water Supply Class II. For sources of water supply that will require complete treatment (coagulation, sedimentation, filtration and disinfections) in order to meet the NSDW.

Class B Recreational Water Class I. For primary contact recreation such as bathing, swimming, skin diving, etc. (particularly those designated for tourism purposes.)

Class C 1) Fishery Water for the propagation and growth of fish and other aquatic resources;

2) Recreational Water Class II (Boating, etc.)

3) Industrial Water Supply Class I. (For manufacturing purposes after treatment).

Class D 1) For agriculture, irrigation, live-stock, watering, etc.

2) Industrial Water Supply Class II (e.g. cooling, etc.)

3) Other inland waters, by their quality, belong to two classification.

(Source: Department of Environment and Natural Resources, Region VI)

WATER QUALITY STANDARD SET BY DENR FOR CLASS A WATERS

PARAMETERS	OEI	NPI
1. pH	6.0-9.0	6.0-9.0
2. Settleable solids (mg/L)	0.3	0.3
3. Total dissolved solids (mg/L)	1200	1000

MPN/100 mL VALUES WHEN FIVE TUBES OF ONLY 10 mL ARE USED

No. of tubes giving positive results out of five	MPN/ 100 mL
0	<2.2
1	2.2
2	5.1
3	9.2
4	16.0
5	>16.0

B. FIGURES

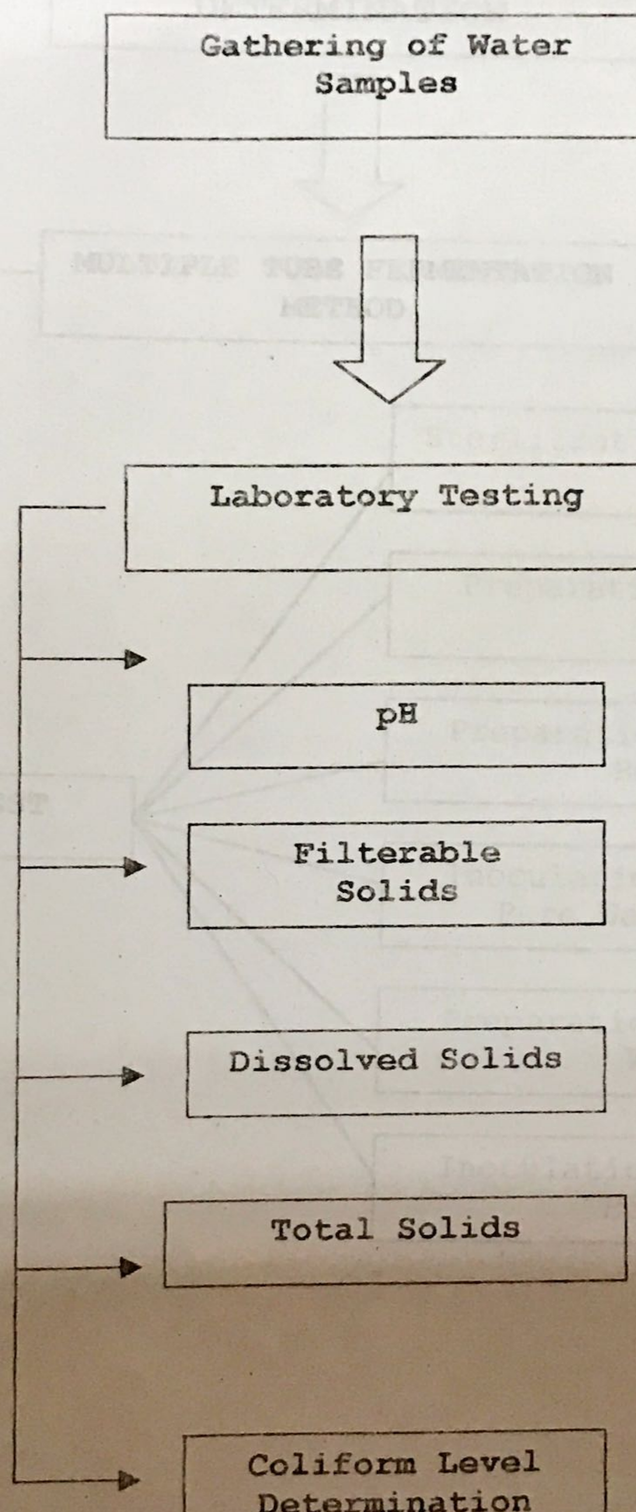
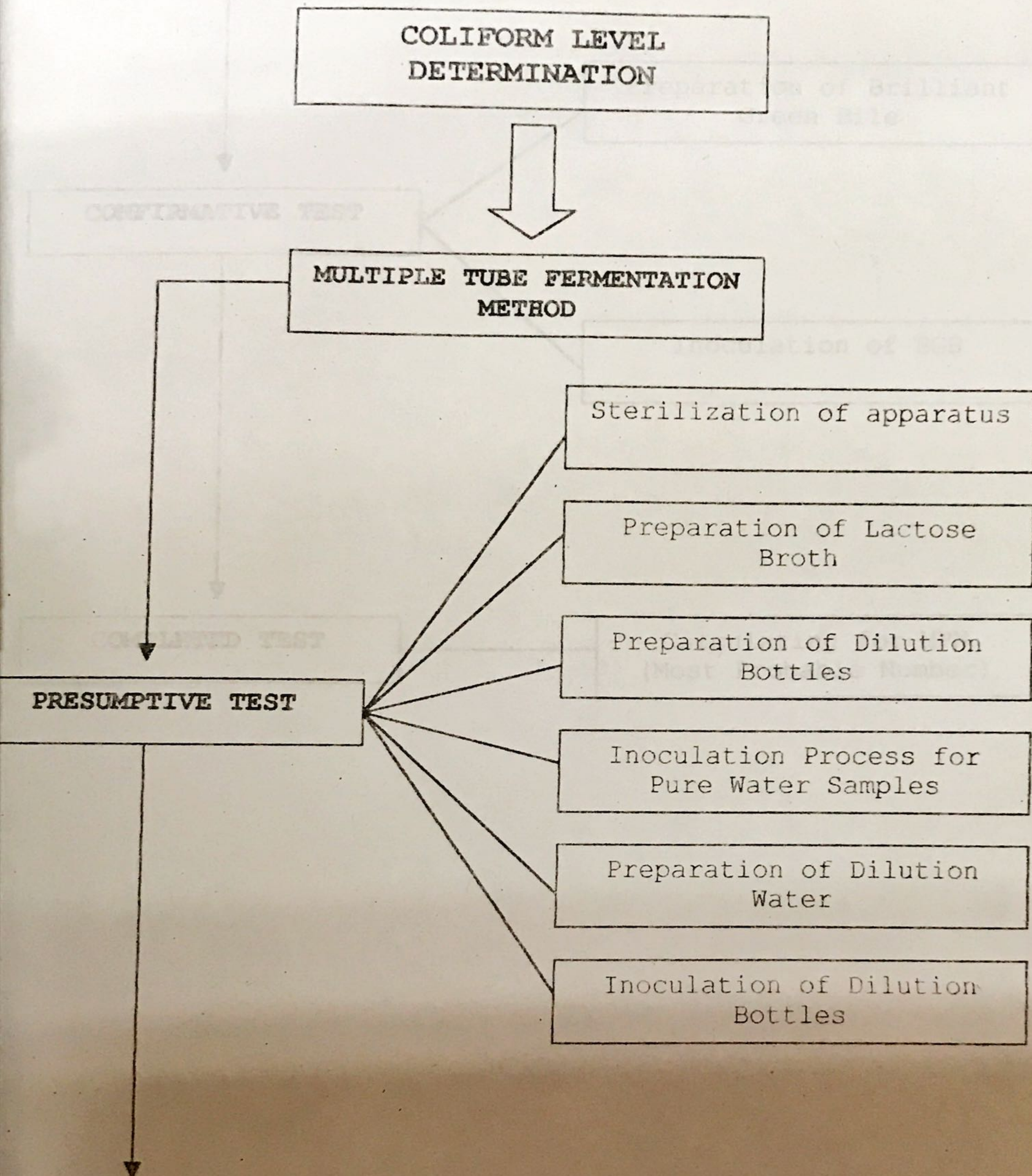


Figure 1. Flow Chart of Methodology


COLIFORM LEVEL DETERMINATION
MULTIPLE TUBE FERMENTATION METHOD
PRESUMPTIVE TEST
Sterilization of apparatus
Preparation of Lactose Broth
Preparation of Dilution Bottles
Inoculation Process for Pure Water Samples
Preparation of Dilution Water
Inoculation of Dilution Bottles

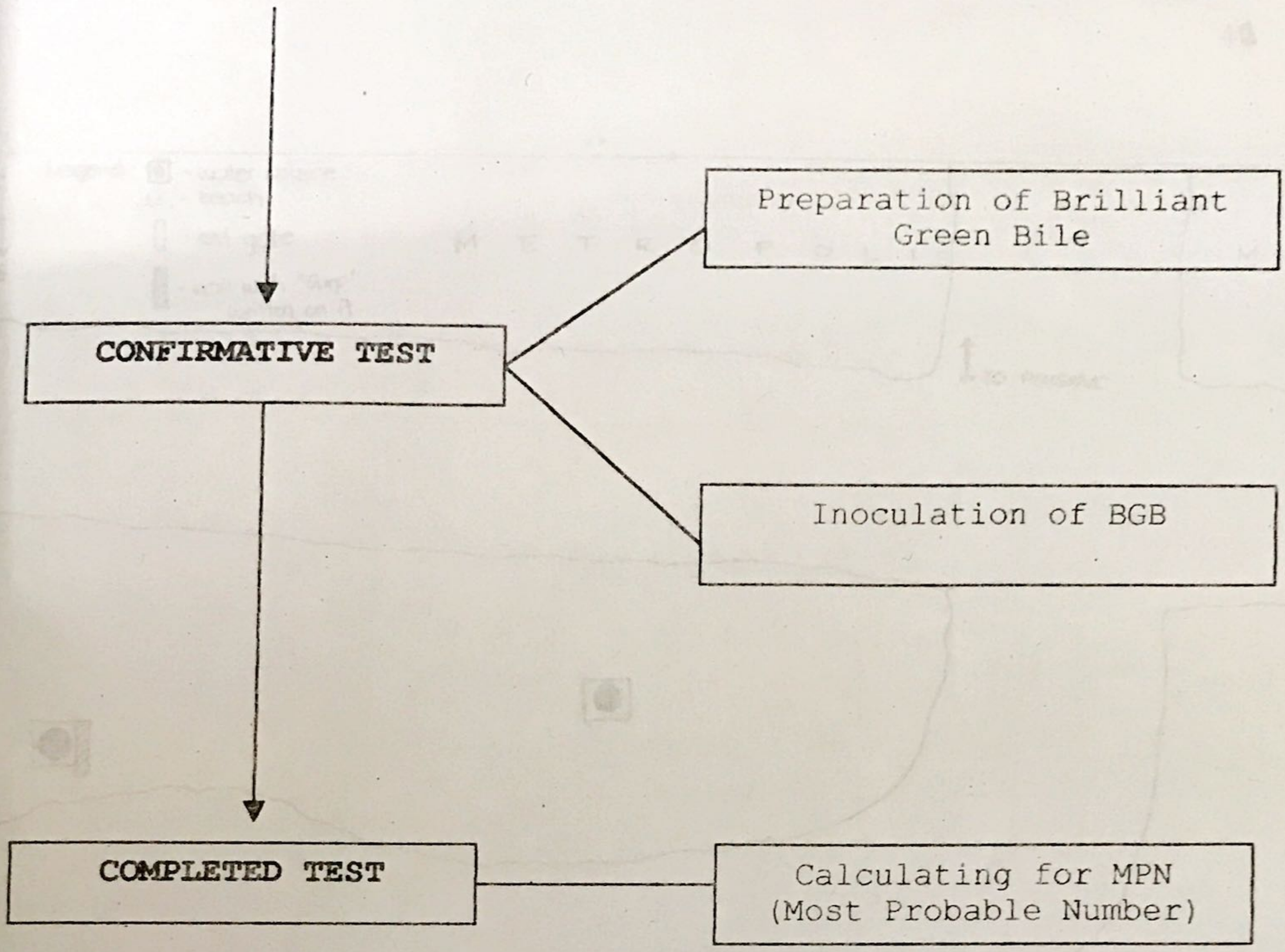


Figure 2. Flowchart of Coliform Level Determination

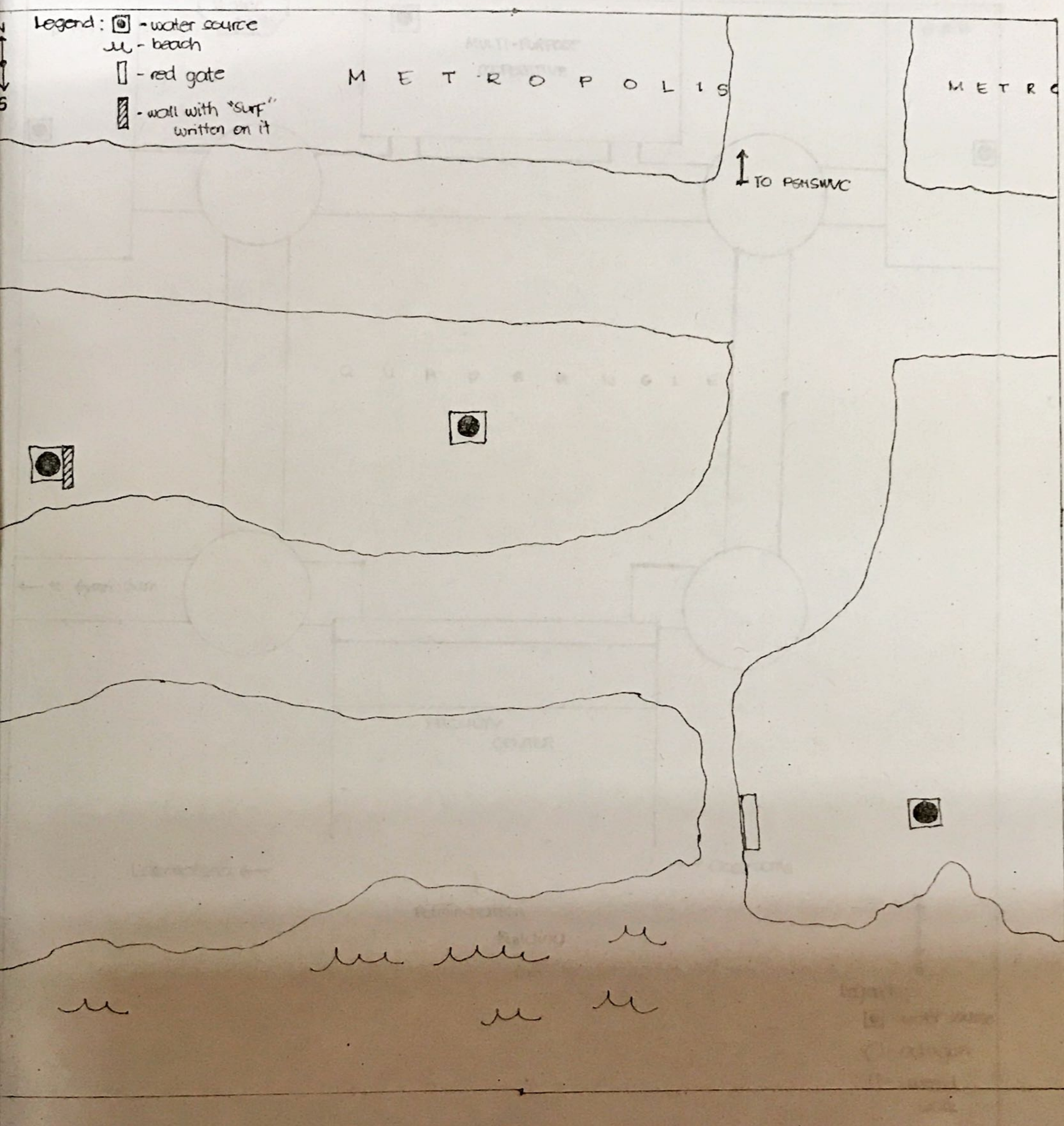


Figure 3: Rough sketch of the map of the Sampling Stations in Brgy. Bitoon, Jaro, Iloilo City, Iloilo, Philippines

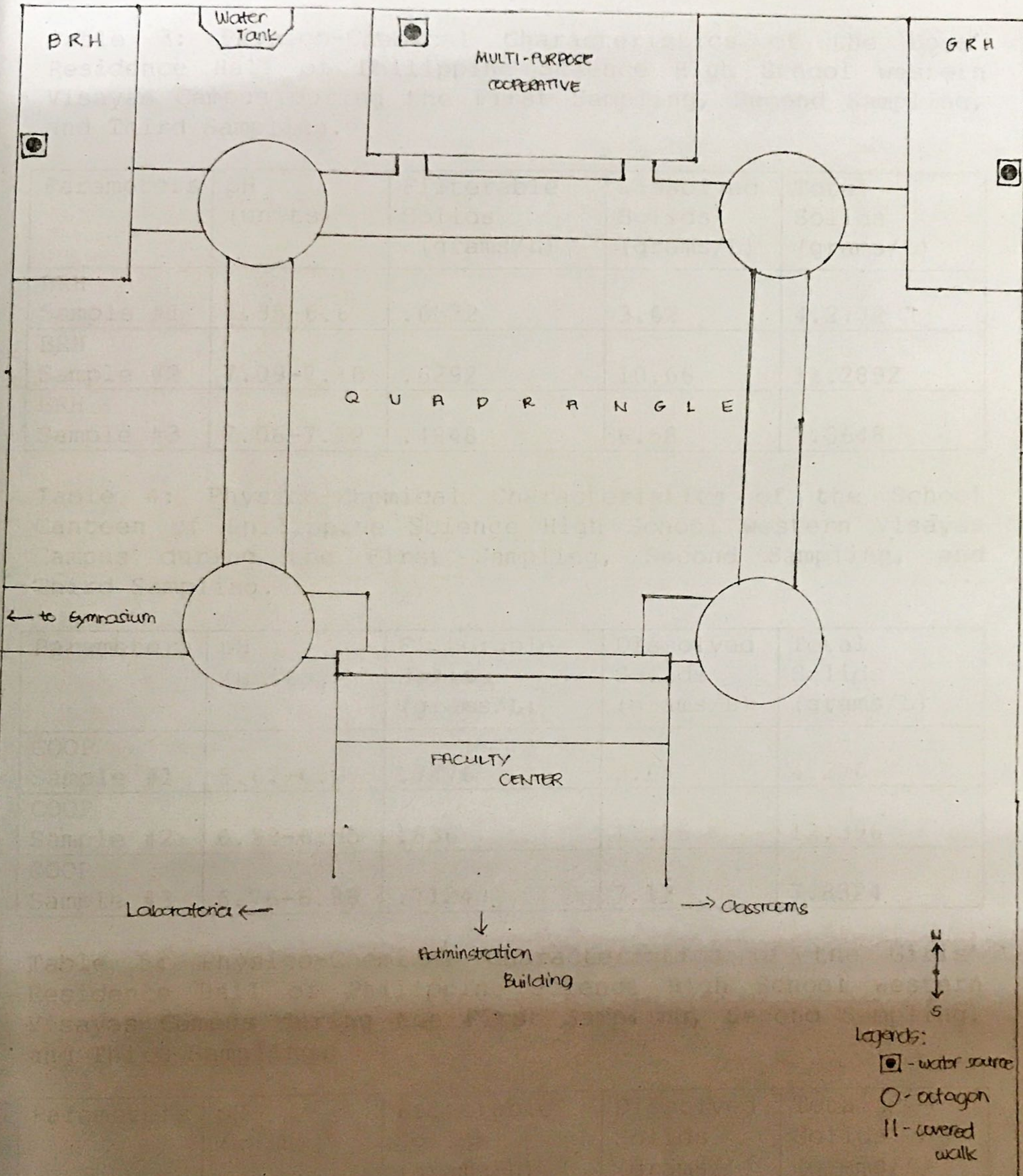


Figure 4: Rough sketch of the map of Philippine Science High School - Western Visayas Campus

C. TABULATED RAW DATA

Table 3: Physico-Chemical Characteristics of the Boys' Residence Hall of Philippine Science High School western Visayas Campus during the First Sampling, Second Sampling, and Third Sampling.

Parameters	pH (units)	Filterable Solids (grams/L)	Dissolved Solids (grams/L)	Total Solids (grams/L)
BRH Sample #1	6.35-6.6	.6572	3.62	4.2772
BRH Sample #2	7.09-7.10	.6292	10.66	11.2892
BRH Sample #3	7.06-7.22	.4848	6.58	7.0648

Table 4: Physico-Chemical Characteristics of the School Canteen of Philippine Science High School western Visayas Campus during the First Sampling, Second Sampling, and Third Sampling.

Parameters	pH (units)	Filterable Solids (grams/L)	Dissolved Solids (grams/L)	Total Solids (grams/L)
COOP Sample #1	5.62-6.07	.7476	3.68	4.276
COOP Sample #2	6.32-6.55	.836	11.56	12.396
COOP Sample #3	6.76-6.88	.7124	7.12	7.8324

Table 5: Physico-Chemical Characteristics of the Girls' Residence Hall of Philippine Science High School western Visayas Campus during the First Sampling, Second Sampling, and Third Sampling.

Parameters	pH (units)	Filterable Solids (grams/L)	Dissolved Solids (grams/L)	Total Solids (grams/L)
GRH Sample #1	6.24-6.36	.9212	0.0316	.9528
GRH Sample #2	6.78-7.03	.4172	0.0276	.4448
GRH Sample #3	7.06-7.30	1.018	0.0384	1.0564

Table 9: Number of Positive and Negative Test tubes in the Presumptive Test after 24 hours from both the pure water samples and dilution water samples of the Six Different Sampling Stations of Philippine Science High School - Western Visayas Campus and Barangay Bitoon, Jaro, Iloilo City, Iloilo, Philippines.

Coliform Level Determination	Pure Water (Presumptive Test) (positive)	Pure Water (Presumptive Test) (negative)	Dilution Water (Presumptive Test) (postitive)	Dilution Water (Presumptive Test) (negative)
BRH	2	4	3	3
COOP	5	1	2	4
GRH	5	1	4	2
Bitoon Site #1	4	2	4	2
Bitoon Site #2	5	1	3	3
Bitoon Site #3	3	3	4	2

Table 10: Number of Positive and Negative Test tubes in the Confirmative Test after 24 to 48 hours from both the pure water samples and dilution water samples of the Six Different Sampling Stations of Philippone Science High School - Western Visayas Campus and Barangay Bitoon, Jaro, Iloilo City, Iloilo, Philippines.

Coliform Level Determination	Pure Water (Confirmative Test) (positive)	Pure Water (Conformative Test) (negative)	Dilution Water (Confirmative Test) (postitive)	Dilution Water (Confirmative Test) (negative)
BRH	2	4	3	3
COOP	4	2	1	5
GRH	3	3	3	3
Bitoon Site #1	4	2	5	1
Bitoon Site #2	3	3	3	3
Bitoon Site #3	2	4	2	4

D. PLATES

Plate 1: Gathering of water samples from Sampling Site: Girls' Residence Hall.

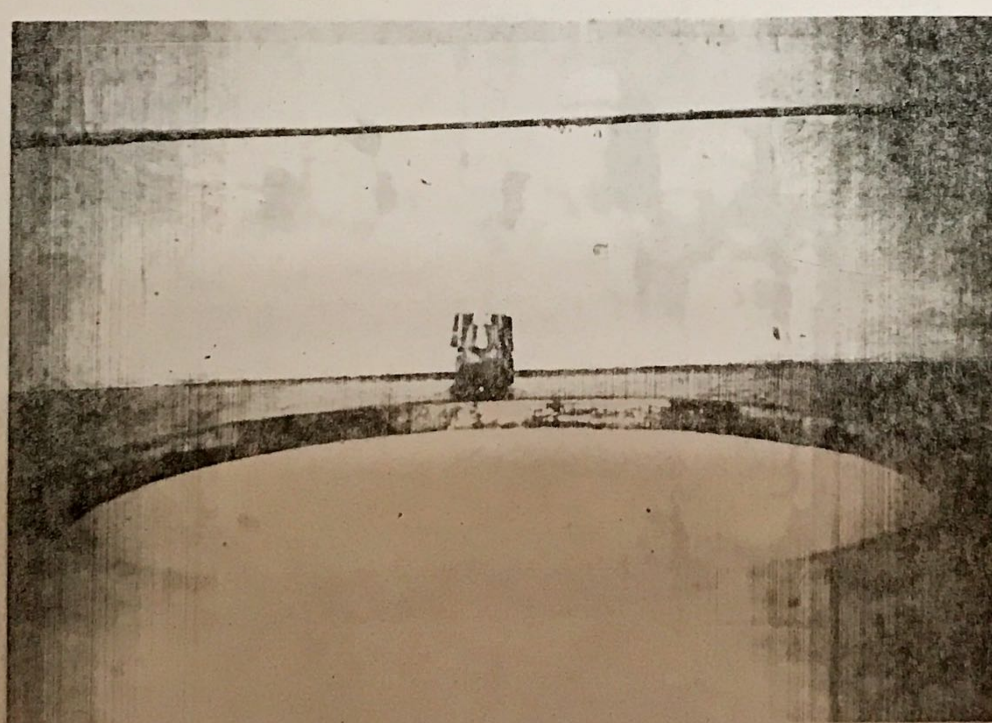


Plate 2: Gathering of water samples from Sampling Site: School Canteen.

Plate 3: Gathering of water samples from Sampling Site: Bitoon #2.

Plate 4: Water samples in bottles.

Plate 5: Getting the Filterable Solids.

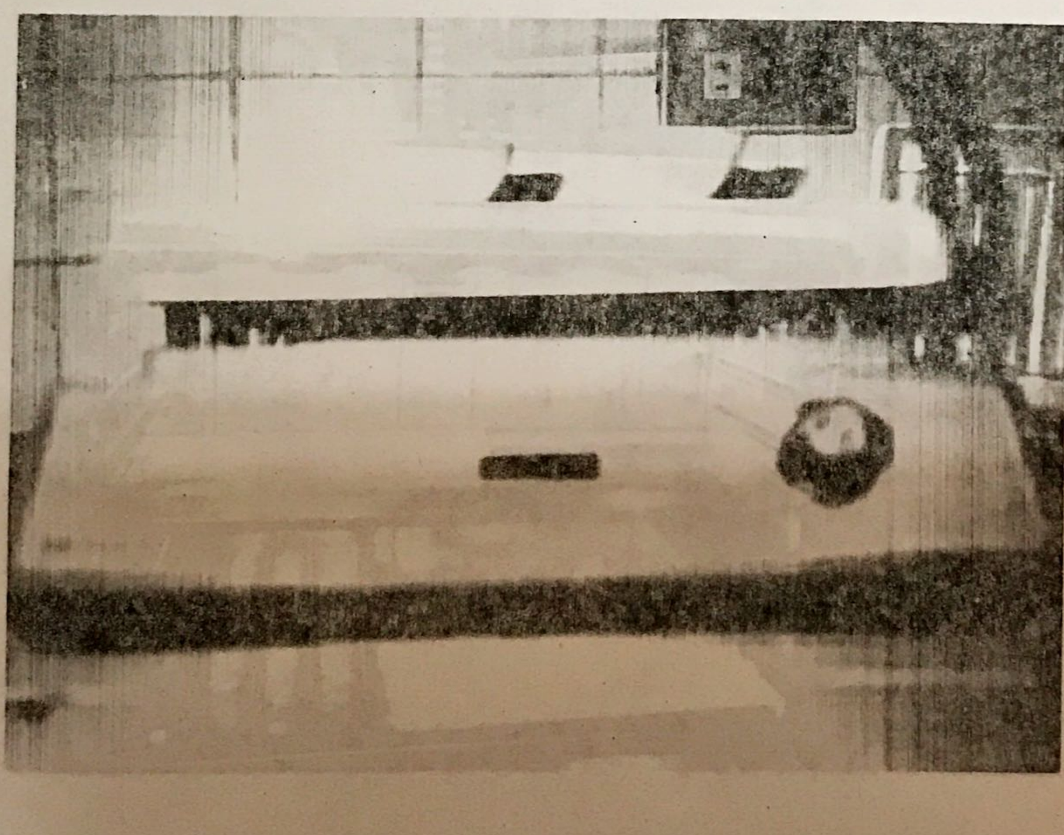


Plate 6: Getting the Dissolved Solids.

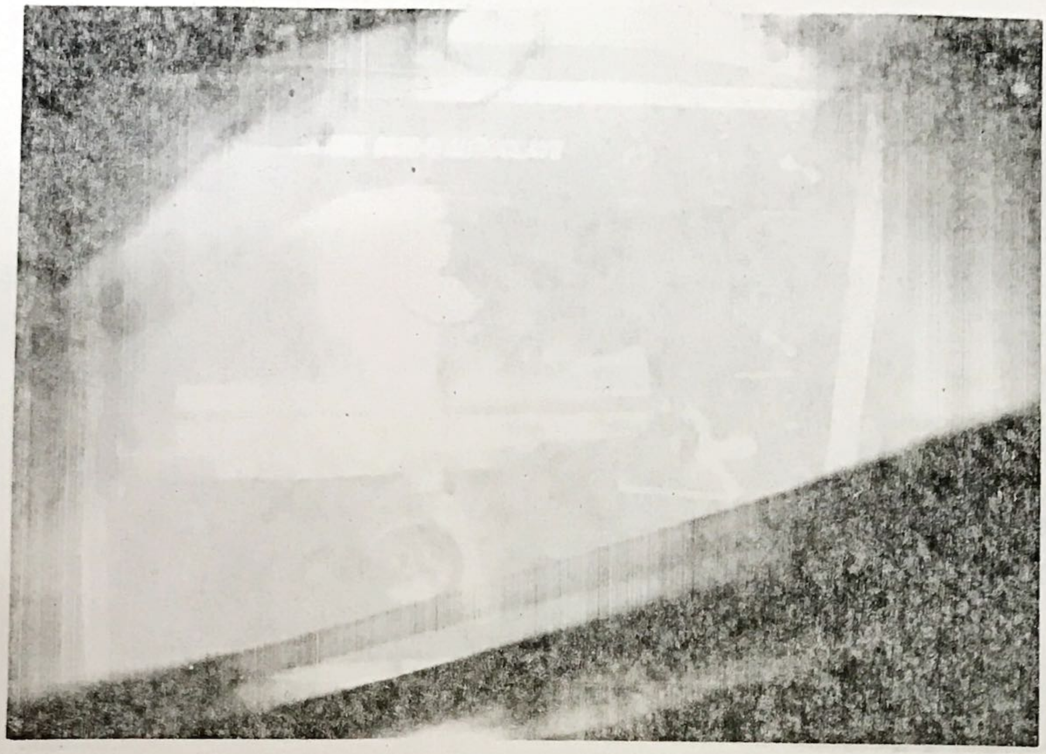


Plate 7: The oven-dried filter papers.

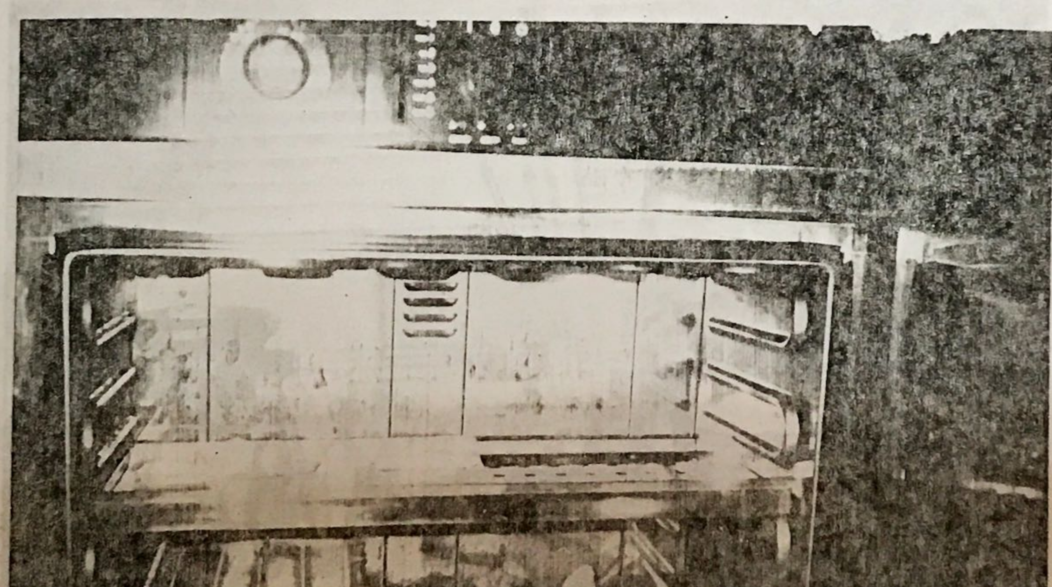


Plate 8: The oven containing the used filter papers.

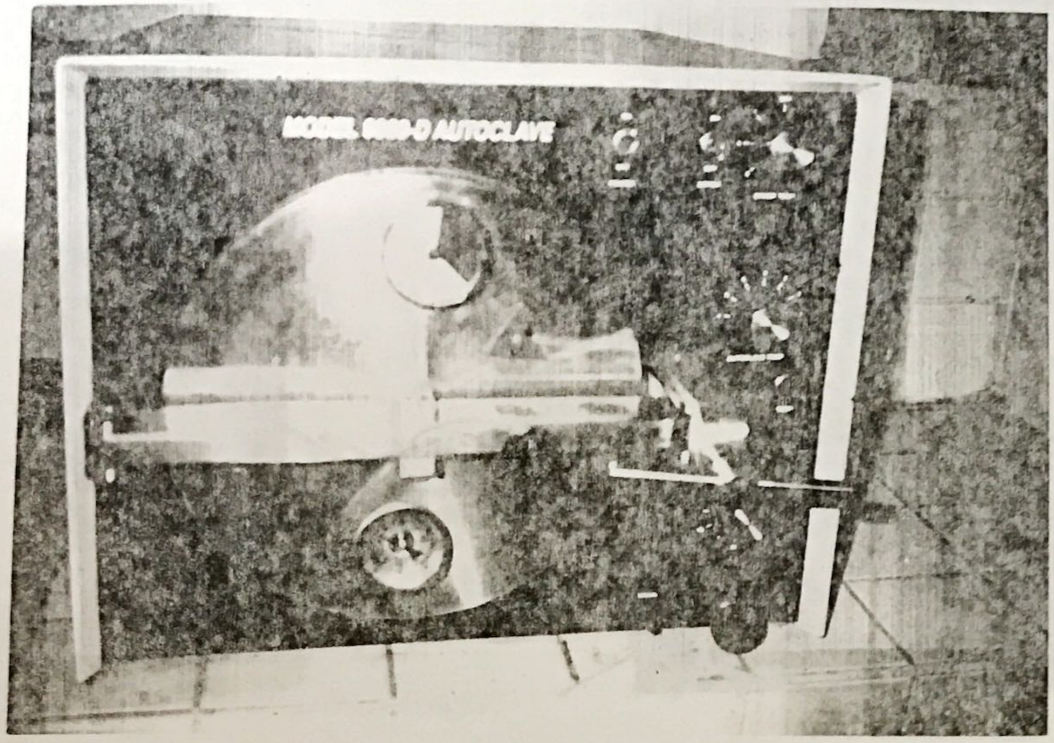


Plate 9: The autoclave for sterilization of apparatus.

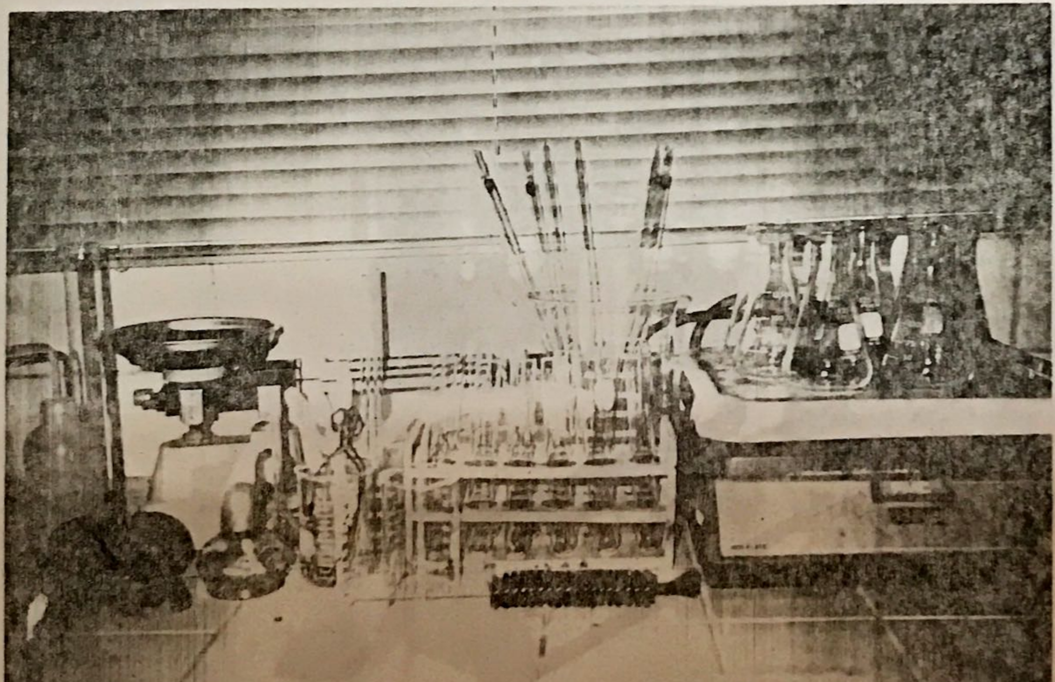


Plate 10: The materials used during the experiment.

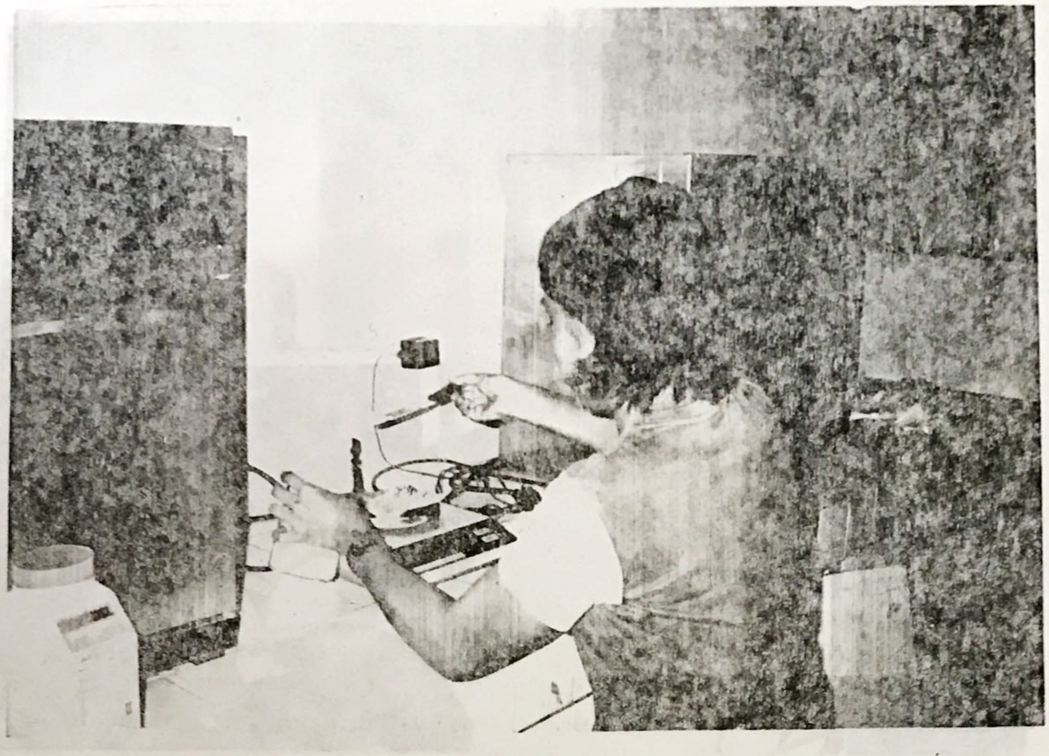


Plate 11: Weighing of the Lactose Broth.

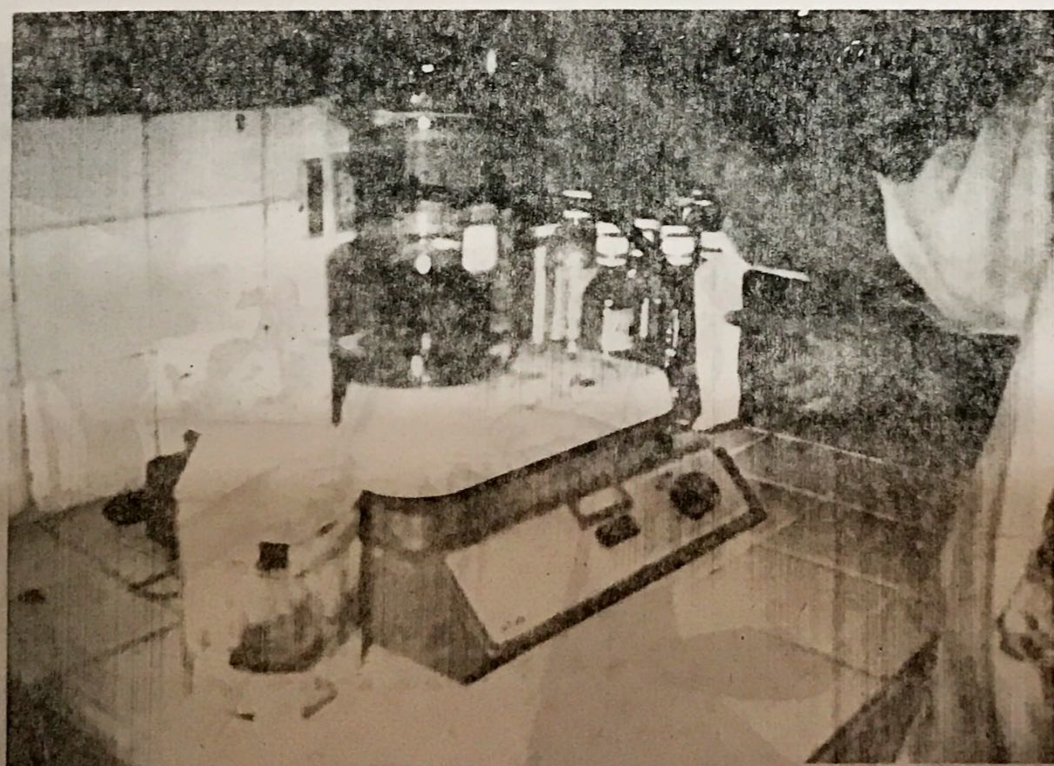


Plate 12: Preparation of the Lactose Broth.

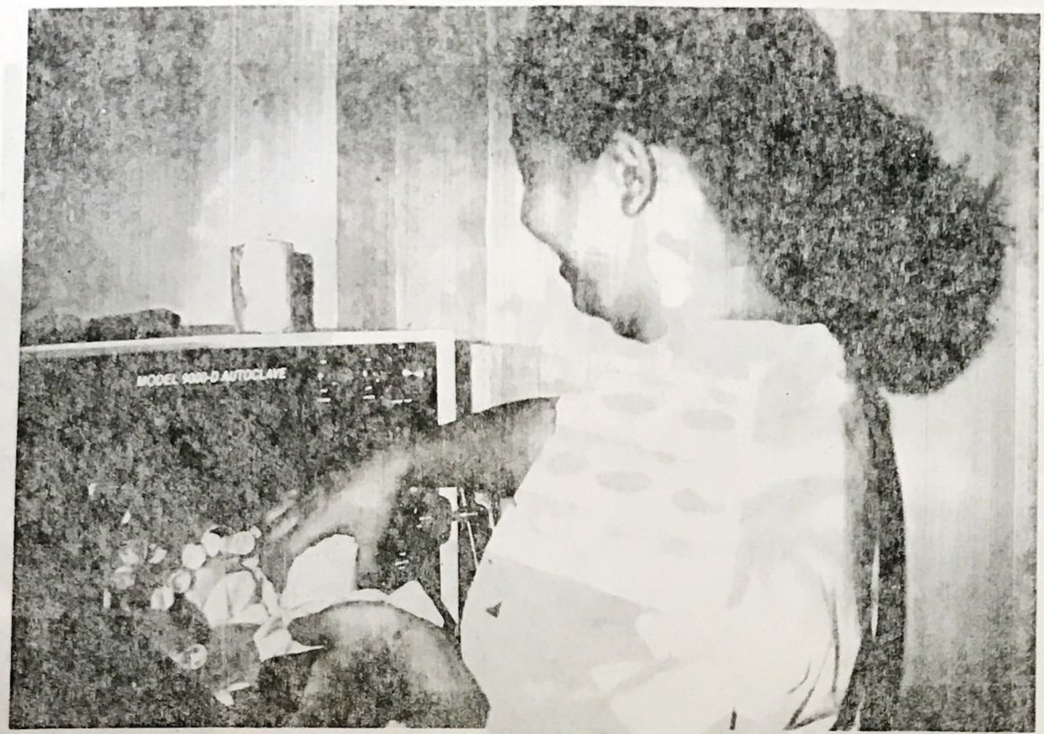


Plate 13: Sterilization of the materials.

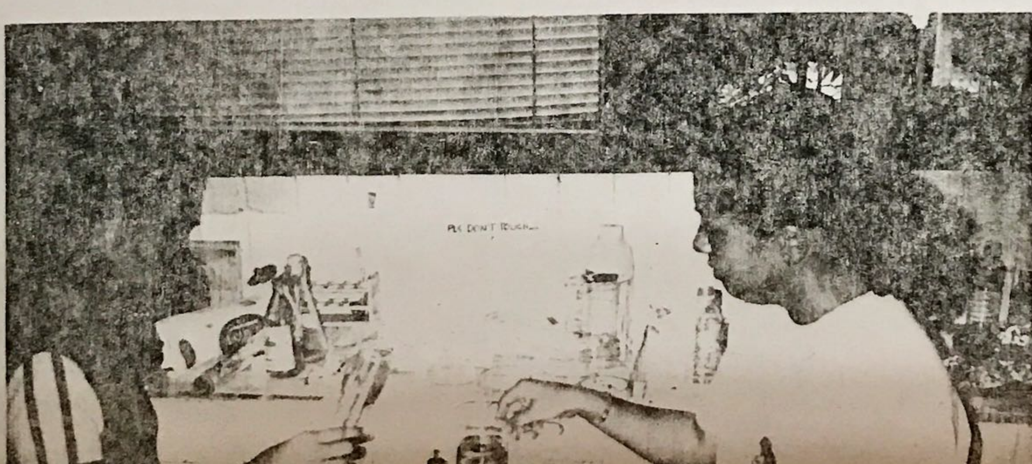


Plate 14: Inoculation Process for Pure Water Samples.

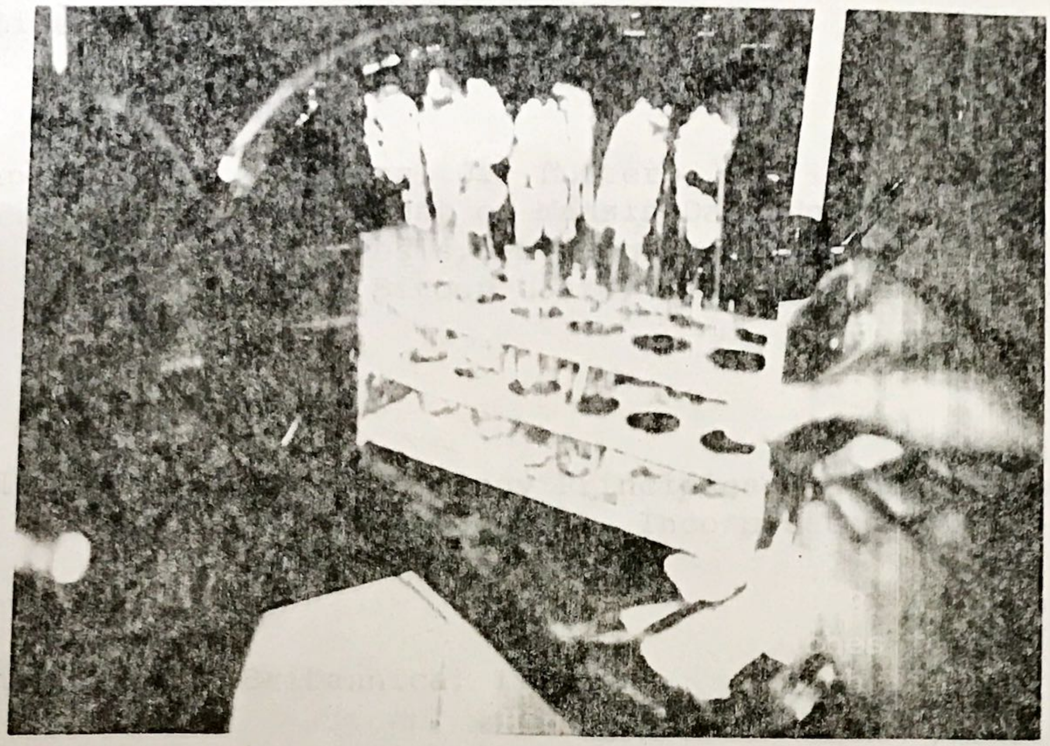


Plate 15; Sterilization of the test tubes containing the lactose broth with the pure water samples.

Literature Cited

Apolonio, A., Billena, J., Luttero, J., 1997. Water Quality Assessment of Maasin Dam. Unpublished High School Thesis, Philippine Science High School, Brgy. Bitoon, Jaro, Iloilo City.

Black,J., 1993.Microbiology Principles and Applications. New Jersey: Prentice hall, Incorporated.

Encyclopedia Britannica, 1993

Estilo, M., Donato, A., Azagra, k., 1998. Physico-Chemical Assessment of the Waters of Bito-on Bay. Unpublished High School Thesis, Philippine Science High School, Brgy. Bitoon, Jaro, Iloilo City.

Flores, K., Jugadora, M., Tibubos, E., 1999. Water Quality Assessment of Different Beaches found in Villa, Iloilo. Unpublished High School Thesis, Philippine Science High School, Brgy. Bitoon, Jaro, Iloilo City.

HTTP://BFHD.WA.GOV/TERMS/INFOTSS.HTML

HTTP:K12SCIENCE.ATI.STEVENSTACH.EDU/CURRICULUM/WATERPROJ/BACTERIA.HTML

Kingfisher Encyclopedia, 1991

Lerman, M., 1986. Marine Biology: Environment, Diversity, and Ecology. The Benjamin/Cummings Publishing Company, Inc., California, p.501.

Miller, K., Levine, J., 1995. Biology. The Benjamin/Cummings Publishing Company, Inc., California, p.1059-1063.

WWW.COTF.EDU/NODULES/WATERQ/WQWATERIMPORT.HTML