# WATER QUALITY AND MACRO-INVERTEBRATES DIVERSITY OF TALON FALLS IN TAYABAS QUEZON

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- **Flerovium, Kiraaa, & Phyllopteryx**

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# Chapter 1

## INTRODUCTION

Access to natural freshwater in the Philippines is very limited due to different anthropogenic activities that take place in every part of the country. Three percent (3%) of the total waters of the world is freshwater, but only 1% of this is available for human consumption because the other two percent (2%) is frozen in the arctic. The freshwater ecosystem is vital for growth and health status of different kinds of forests and organisms. Much of the freshwater is a product of precipitation, and when water enters a wetland, it slows down and moves around wetland plants. Much of the suspended sediment drops out and settles to the wetland floor. Plant roots and microorganisms on plant stems and in the soil absorb excess nutrients in the water from fertilizers, manure, leaking septic tanks and municipal sewage (United States Environmental Protection Agency, USEPA, 2006).

According to Karr (1999), "biological measures provide a much integrated and comprehensive assessment of the health of a water body over time". A well-balanced and functioning biological community is one of the best indicators of a healthy stream, capable of providing vital ecosystem services. Benthic macroinvertebrates (bottom-dwelling organisms including aquatic insects, crayfish, clams, snails, and worms) are often used in studies to determine the quality of waters because of their high numbers, known pollution tolerances, limited mobility, wide range of feeding habits, varied life spans, and dependence on the land environment around the stream. When chemical grab samples are

taken, they are really a snapshot of the water at that moment, that can change rapidly, but the macroinvertebrates are living there all the time. Their composition will be affected by either periodic episodes of poor water quality or continuous poor water quality. In addition, assessing a freshwater ecosystem is important to determine the overall status of the water quality for the benefit of not only human species but also to other fauna that inhabits the area. The term freshwater do not have the same meaning as potable water. Much of the Surface Water and Ground Water is not suitable for drinking purposes without any form of filtration or treatment; this is due to the presence of chemical or biological contaminants. There are several ways of assessing water quality in lotic and lentic water bodies. One of the common ways of assessing the water quality is through physico-chemical parameters; which determine the temperature, pH, Turbidity, Dissolve Oxygen, Fecal Coliforms, etc. Physico-chemical parameters, provides snapshots of the condition of a waterbody but do not provide an integrative measure of overall health of a stream and can, at times, inadequately identify impaired waters (United States Environmental Protection Agency, USEPA, 2005). In connection with this, the researchers studied a certain freshwater ecosystem at Tayabas, Quezon.

The location of the study is in Brgy. Ilayang Bukal, Tayabas, Quezon. The locals use the water for their daily consumption like drinking, cleaning, etc. The present condition of the site is that many people tend to visit the area during holy week and with their presence, pollution, encounter with the wildlife and intervention in the natural habitat is inevitable, thus the natural ecosystem is

disturbed and preventive countermeasures is needed to maintain the terrain and the richness of the area.

Such ideas had driven the researchers of this study to conduct an assessment of the water quality and macro-invertebrates in the three sampling stations of Talon falls for the months of June, August, October and December.

**Statement of objectives**

The study aimed to assess of the water quality of Talon falls in relation to macroinvertebrates diversity in the area.

Specifically, the study sought to determine:

1. the physico-chemical properties of samples in terms of:
    1.1. ammonia;
    1.2. chloride;
    1.3. phosphate;
    1.4. nitrate;
    1.5. sulfate;
    1.6. dissolved oxygen;
    1.7. pH;
    1.8. temperature;
    1.9. total dissolved solids;
    1.10. total suspended solids;
    1.11. total hardness

2. the microbial properties of samples in terms of:
   2.1. total coliform
   2.2. fecal coliform
3. whether there are significant differences among the four sampling periods and three sampling station in terms of:
   3.1. each of physico-chemical properties
   3.2. each of microbiological properties
4. the species diversity using Simpson and Shannon-Weiner diversity index
5. classification of macro-invertebrates present in the study area in terms of pollution tolerance
6. perception of the locale on the ways of conserving the Talon falls through interview

**Statement of hypothesis**

The following null hypotheses are tested in this study:

1. four sampling periods in terms of the physico-chemical properties of water per site;

2. three sites in terms of physico-chemical properties of water per sampling period

**Statement of significance**

Results of this study are significant contribution in the field of environmental management. Results of this study tend to help the local government of Tayabas, Quezon by assessing their natural ecosystem and by providing information about the current state of Talon falls that can be used choosing the techniques or programs applicable on protecting the falls. If the Talon falls is successfully protected, the community of the barangay that rely in the falls will continuously benefit.

**Scope and Limitations**

This study focuses on determination of physico-chemical and the microbiological properties of the water. The analysis of Ammonia, Chloride, Sulfate, Dissolve Oxygen, pH, Temperature, Total hardness, Total dissolved solids, Total suspended solids were performed at the TUP-Laboratory. The other four properties of water from Talon falls such as Nitrate, Phosphate, Total Coliform and Fecal Coliform were done by Mach Union Water Laboratory. Macro-invertebrates that inhabit the area were identified and quantified using the Shannon-Weiner diversity index and Simpson's diversity index. The macroinvertebrates were then grouped according to its pollution tolerance to further determine the health of the falls.

The sampling method used for the diversity of species is the Dip-net method and random sampling and for the collection of water, Grab Sampling was used. Residents near the site were interviewed to identify the importance of the site and its rules and regulations if it was properly implemented.

Significant difference among the three stations per sampling periods and among four sampling periods per site in terms of physico-chemical properties of water were determined by testing null hypothesis using Analysis of variance. No attempt, however, were done to find out which pair or pairs of the three sites and pair or pairs of the four sampling periods significantly differ.

The other parameters for Class AA waters were not included such as transparency, color and turbidity, Fluoride, Pesticide, Phenols and Heavy metals were not measured. In Bio-assessment the collection of samples are limited to Macro-invertebrates specifically the crustaceans, insects and mollusks. Initially the turbidity was planned to be measured since a Secchi disk was prepared, but upon assessment the shallow water of the three sites in Talon falls were not deep enough to measure the said physical property of the water. Analysis of variance for the month of June was not applicable since the results are means of three trials. The study did not use Hilsenhoff's Biotic Index to estimate the overall tolerance of the community to the sampled area since most of the macroinvertebrates collected has its own pollution tolerance. The certificate of identification for the aquatic insects will not be provided by the National Museum, it is instead identified using morpho-species and its family was determined using available keys and references. Crustaceans and Aquatic Insects are the only specimens that were not identified to the species level due to Taxonomic Impediments.

The sampling periods are limited in the months of June, August, October, and December

# Chapter 2

## REVIEW OF RELATED LITERATURE AND STUDIES

This chapter provides discussions of facts and information, as well as journals and studies to which the research is related.

### Related Literature

### 2.1 Locale of the Study

Within the Province of Quezon, Tayabas is a land-locked town which is situated at the south-eastern of "Mt. Banahaw" – one of the famous volcanoes in the country. It is surrounded by several municipalities of Quezon Province such as Lucban and Sampaloc to the north; Mauban to the East; Atimonan and Pagbilao to the south-east; Lucena City to the south; and Sariaya to the west. It shares its boundary with the Province of Laguna in its north-eastern extremity. From southeast of Manila, it lies some 150 km. and approximately 10 km. from the provincial capital, Lucena City.

Tayabas has a total land area of 23,095 hectares divided among its 66 barangays, 19 of which are within the Poblacion; 11 are booming sub-urban and 36 classified as rural with respective areas ranging from a mere 10 hectares to an enormous 3,002.41 hectares. The compact urban core measures only 82.15 hectares which is less than one percent of the total land area. (Tayabas.gov.com)




**Fig. 1 – The land area of Tayabas Quezon highlighted in Red adjacent to the Mount Banahaw.**

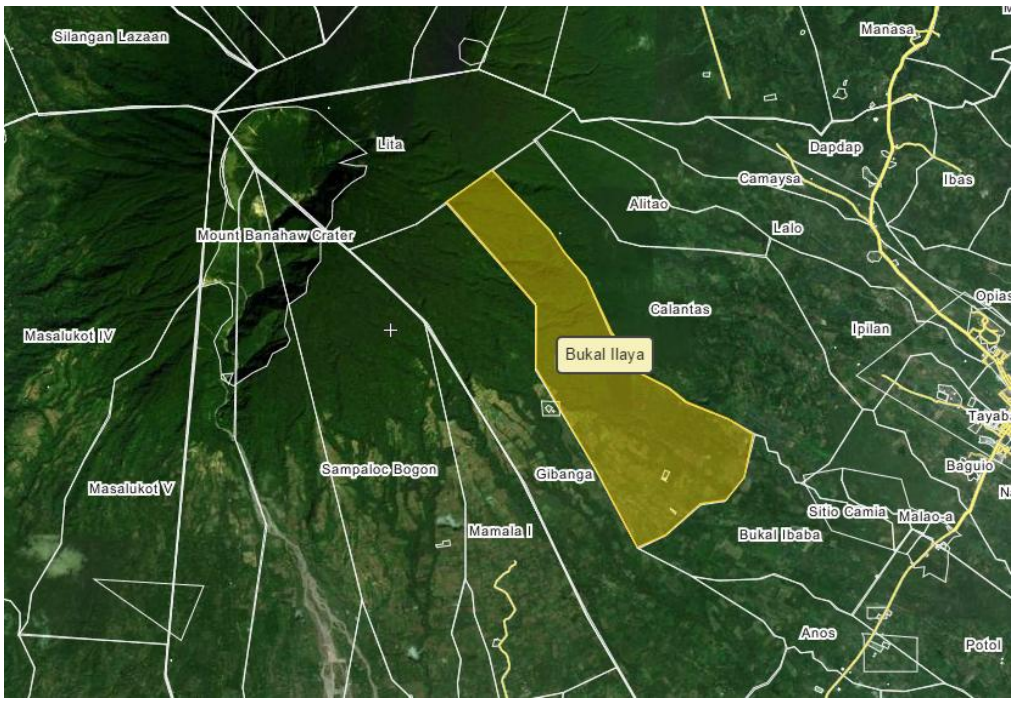



**Fig. 2 – Baranggay Bukal Illaya**

## 2.2 Physico-chemical Parameters

### 2.2.1 Ammonia

Ammonia or $NH_3$ is one of the most important pollutants in the aquatic environment because of its relatively highly toxic nature and its ubiquity in surface water systems. It is discharged in large quantities in industrial, municipal and agricultural waste waters. In aqueous solutions, ammonia assumes two chemical forms: $NH_4^+$ - ionized (less/nontoxic) and $NH_3$ – unionized (toxic).

The relative concentration of ionized and unionized ammonia in a given ammonia solution are principally a function of pH, temperature and ionic strength of the aqueous solution.

### 2.2.2 Chloride

Chloride, in the form of the $Cl^-$, is one of the major inorganic anions, or negative ions, in saltwater and freshwater. It originates from the dissociation of salts, such as sodium chloride or calcium chloride, in water. These salts, and their resulting chloride ions, originate from natural minerals, saltwater intrusion into estuaries, and industrial pollution. Possible sources of manmade salts that may contribute to elevated chloride readings. Sodium chloride and calcium chloride, used to salt roads, contribute to elevated chloride levels in streams. Chlorinated drinking water and sodium-chloride water softeners often increase chloride levels in wastewater of a community. In drinking water, the salty taste produced by chloride depends upon the concentration of the chloride ion.

### 2.2.3 Nitrate

Nitrate generally occurs in trace quantities in surface water. It is the essential nutrient for many photosynthetic autotrophs and has been identified as the growth limit nutrient. It is only found in small amounts in fresh domestic wastewater, but in effluent of nitrifying biological treatment plants, nitrate may be found in concentrations up to 30 mg nitrate as nitrogen/L ($19^{th}$ Edition, Standard Methods, 1995). Nitrate is a less serious environmental problem, it can be found in relatively high concentrations where it is relatively nontoxic to aquatic organisms. Nitrates and nitrites are nitrogen-oxygen chemical units which combine with various organic and inorganic compounds. The major sources of nitrates in drinking water are runoff from fertilizer use; leaking from septic tanks, sewage; and erosion of natural deposits.

### 2.2.4 Phosphate

Phosphates are among the greatest contributors to phosphate content in lakes and rivers because phosphate containing compounds in the past have been used in detergent formulations as water softeners. Phosphate is not toxic to plants or animals. In fact, it is a plant nutrient which stimulates the growth of aquatic weeds and algae. This may cause lakes and rivers to become clogged and overrun with plants.

### 2.2.5 Sulfate

Sulfate ($SO_4^{2-}$) can be found in almost all natural water. The origin of most sulfate compounds is the oxidation of sulfite ores, the presence of shale, or the industrial wastes.

According to Lenntech (2005). Sulfate is one of the major dissolved components of rain. High concentrations of sulfate in the water we drink can have a laxative effect when combined with calcium and magnesium, the two most common constituents of hardness. Bacteria, which attack and reduce sulfates, form hydrogen sulfide gas ($H_2S$). People who are not used in drinking water with high levels of sulfate can experience dehydration and diarrhea. Children are often more sensitive to sulfate than adults. As a safety measure, water with a sulfate level exceeding 400 mg/l should not be used in the preparation of baby food. Older children and adults become used to high sulfate levels after a few days.

**2.2.6 Dissolved oxygen**

DO is essential for aquatic life. A low DO (less than 2mg/l) would indicate poor water quality and thus would have difficulty in sustaining many sensitive aquatic lives. The concentration of dissolved oxygen in a stream is affected by many factors such as temperature because oxygen is more easily dissolved in cold water, Flow since oxygen concentrations vary with the volume and velocity of water flowing in a stream. Faster flowing white water areas tend to be more oxygen rich because more oxygen enters the water from the atmosphere in those areas than in slower, stagnant areas. Altitude, because oxygen dissolved more easily into the water at low altitude compared to high altitude. Dissolved and suspended solids also affects the dissolved oxygen since it easily dissolves into the water with low levels of dissolved or suspended solids.

### 2.2.7. pH

pH is an important limiting chemical factor for aquatic life. If the water in a stream is too acidic or basic, the $H^+$ or $OH^-$ ion activity may disrupt aquatic organisms' biochemical reactions by either harming or killing the stream organisms.

Streams generally have pH values ranging between 6 and 9, depending upon the presence of dissolved substances that come from bedrock, soils and other materials in watershed. Changes in pH can change aspects of water chemistry. For example, as pH increases, smaller amounts of ammonia are needed to reach the level that is toxic to fish. As pH decreases, the concentration of metal may increase because higher acidity increases their ability to be dissolved from sediments into the water.

### 2.2.8. Temperature

Temperature can exert great control over aquatic communities. If the overall water body temperature of a system is altered, an aquatic community shift can be expected.

In water above 30°C, a suppression of all benthic organisms can be expected. Also, different plankton groups will flourish under different temperatures. For example, diatoms dominate at 20 - 25°C, green algae dominate at 30 - 35°C, and cyano-bacteria dominate above 35°C.

### 2.2.9. Total Dissolved Solids

The total dissolved solids (TDS) in water consist of inorganic salts and dissolved materials. In natural waters, salts are chemical compounds comprised of anions such as carbonates, chlorides, sulphates, and nitrates (primarily in ground

water), and cations such as Potassium (K), Magnesium (Mg), Calcium (Ca), and Sodium (Na). In ambient conditions, these compounds are present in proportions that create a balanced solution. If there are additional inputs of dissolved solids to the system, the balance is altered and detrimental effects may be seen. Inputs include both natural and anthropogenic source.

**2.2.10. Total Suspended Solids**

Total suspended solids are an indication of the amount of erosion that took place nearby or upstream. This parameter would be the most significant measurement as it would depict the effective and compliance of control measures.

The series of sediment-induced changes that can occur in a water body may change the composition of an aquatic community. First, a large volume of suspended sediments reduce light penetration, thereby suppressing photosynthetic activity of phytoplankton, algae, and macrophytes. This leads to fewer photosynthetic organisms available to serve as food sources for many invertebrates. As a result, overall invertebrate numbers may also decline, which may then lead to decreased fish populations.

In addition, sediment may interfere with essential functions of organisms. The numbers of filter-feeding invertebrates decline if their filter mechanisms are choked by suspended particles. Some zooplankton suffer decline due to clogged feeding mechanisms. Likewise, fish may suffer clogging and abrasive damage to gills and other respiratory surfaces. Abrasion of gill tissues triggers excess mucous secretion, decreased resistance to disease, and a reduction or complete cessation of feeding. Suspended sediment may also affect predator-prey relationships by inhibiting predators' visual abilities.

The settling of suspended solids from turbid waters threatens benthic aquatic communities. Deposited particles may obscure sources of food, habitat, hiding places, and nesting sites. Most aquatic insects will simply drift with the current out of the affected area. Benthic invertebrates that prefer a low-silt substrate, such as mayflies, stoneflies, and caddis flies, may be replaced by silt-loving communities.

### 2.2.11. Total Hardness

Hardness in water is that characteristic, which "prevents the lathering of soap". This is due to presence in water of certain salts of calcium, magnesium and other heavy metals dissolved in it. A sample of hard water, when treated with soap does not produce lather, but on other hand forms a white scum or precipitate. This precipitate is formed, due to the formation of insoluble soaps of calcium and magnesium.

Thus, water which does not produce lather with soap solution readily, but forms a white curd, is called hard water. On the other hand, water which lathers easily on shaking with soap solution, is called soft water. Such water consequently does not contain dissolved calcium and magnesium salts in it.

## 2.3. Microbiological Parameters

### 2.3.1. Total Coliform and Fecal Coliform

Microbiological test is to detect the level of pollutions caused by living thing especially human that live or work in the area especially upstream of the site.

These tests are based on coliform bacteria as the indicator organism. The presence of these indicative organisms is evidence that the water has been polluted with feces of humans or other warm-blooded animals.

**2.4. Macro-invertebrates**

Macro-invertebrates are used as bio-indicators of a stream health because it has a little mobility, a primary source of food for many fish, good indicators of localized condition, it is has a simple sampling techniques and because of the threats to macro-invertebrates diversity such as sedimentation, habitat loss, and chemical pollution the researcher can make a hypothesis about the condition of the stream (Chadde, 2007).

Benthic macro-invertebrates (bottom-dwelling organisms including aquatic insects, crayfish, clams, snails, and worms) are often used in studies to determine the quality of waters because of their high numbers, known pollution tolerances, limited mobility, wide range of feeding habits, varied life spans, and dependence on the land environment around the stream. When chemical grab samples are taken, they are really a snapshot of the water at that moment, that can change rapidly, but the macro-invertebrates are living there all the time. Their composition will be affected by either periodic episodes of poor water quality or continuous poor water quality (PENNSTATE, 2014). A group of environmental scientist from enviroscience concluded that benthic macro-invertebrates, especially aquatic insects, can be a useful tool in biological monitoring program. Macro-invertebrate communities that resides in an aquatic system long enough to reflect the chronic effects of pollutants, yet short enough to respond respectively

to relatively acute changes in water quality. Unlike fish, these populations tend to be relatively immobile, and as a result are continuously exposed to the constituents of the surface water they inhabit. Thus, the location of chronic sources of pollution often can be pinpointed by comparing communities of these organisms.

## 2.5. Diversity Index

### 2.5.1. Simpson's Diversity Index

The Simpson index was introduced in 1949 by Edward H. Simpson to measure the degree of concentration when individuals are classified into types.

Simpson's Diversity was used in determining the diversity of plants and animals. The number of organisms of all species collected were needed for the computation of the index (Barcebal, Tagala, 2014). A Simpson's Diversity index of 1 means that the area is completely diverse but this situation is virtually impossible. Hence the closeness of SDI to 1 means that the area is more diverse. It is written as;

$$D = \frac{\sum ni(ni-1)}{N(N-1)}$$

### 2.5.2. Shannon-Weiner Diversity Index

The Shannon index has been a popular diversity index in the ecological literature, where it is also known as Shannon's diversity index, the Shannon–Wiener index, the Shannon–Weaver index and the Shannon entropy. The measure was originally proposed by Claude Shannon to quantify the entropy (uncertainty or information content) in strings of text.

Shannon-Weiner Index was first used to assess the water quality and described the longitudinal variations of the benthic community structure of the water. Typically, the value of the index ranges from 1.5 (low species richness and evenness) to 3.5 (high species evenness and richness). It is most often calculated as follows:

$$\mathrm{H} = \sum_{i=1}^{s} pilnpi$$

**Related Studies**

Elias et al. (2014) conducted a research entitled "Study on Freshwater Macroinvertebrates of Some Tanzanian Rivers as a Basis for Developing Biomonitoring Index for Assessing Pollution in Tropical African Regions". They concluded that orders with greater diversity of macro-invertebrate families offer a wide range of tolerance to pollution and, thus can potentially be used to develop a biomonitoring index for evaluating pollution in tropical African rivers. They assessed macroinvertebrates and physicochemical parameters at 15 sites along five rivers in Kilimanjaro region, Tanzania, with the aim of understanding their ecological status and setting a base to the development of a biological index for tropical regions. Investigated rivers that occur within Pangani basin include Karanga, Rau, Lumbanga, Sere, and Umbwe. Sampling sites were categorized according to the level of water and habitat quality as follows: reference or least impacted (4 sites), moderately impacted (5 sites), and highly impacted (6 sites) sites. A total of 12,527 macroinvertebrates belonging to 13 orders and 48 families were recorded. The highest total abundance of 4,110 individuals per $m^2$ was found in Karanga river, while Umbwe river had the lowest with 1,203 individuals per $m^2$. Chironomidae was the most abundant family and the least were Hydridae and Thiaridae, each having 5 individuals per $m^2$. High numbers of taxa were noted among the orders: Ephemeroptera, Odonata, Diptera, and Trichoptera.

Another study by Banwa et al. (2013) conducted a study based on accessibility site. Sampling plots were based on altitudinal gradients. The taxon composition and richness of macro-invertebrates, index of similarity and pollution status of these sites were determined. Samples were handpicked and collected

using the indigenous method. Collected samples were identified using standard books and monographs and taxonomic keys provided by Myer et al., n.d. The samples were grouped to taxa based on the Environmental Protection Agency adopting the Ireland EPA biotic system for macro-invertebrates. There were 15 macro-invertebrates species belonging to 14 genera under 9 taxa. The sites show similarity index of 61.5 percent indicating more taxa at the most accessible sites probably due to human introduction. The biotic index of the sites indicated a moderately polluted status. This implies the indigenous practice of recycling back organic litters back to the rice fields. These indigenous practices could have maintained the food web and at the same time preserving the biological diversity in the rice terraces of the Cordillera Region.

Maagad et al. (2013) made a study in Illigan River entitled "Water Quality in Iligan River, Mindanao, Philippines Using Benthic Macro-invertebrates as Bio-indicators". A total of 18 taxa were collected and were represented by Coleoptera, Diptera, Odonata, Plecoptera, Trichoptera, Hirudenia, Veneroida, Archaeogastropoda, Mesogastropoda, Basommatophora, and Decapoda. Hilsenhoff's Biotic Index (BI) shows that the river system has a good water quality. However, the BI value also implies some degree of organic pollution. Furthermore, presence of Chironomidae (non-biting midges), a pollution-tolerant macro-invertebrate family, as the most abundant taxa indicates that pollution is apparent in the area.

A case study in Koratty, Kerala, India were conducted by Kripa et al. (2012) entitled "Aquatic Macroinvertebrates as Bioindicators of Stream Water Quality". The paper discusses the results of an attempt to test the sustainability of

aquatic macroinvertebrates as bioindicators of stream water quality in a natural water course locally referred as Koratty chal that runs through the length of agricultural lands in Koratty region. Rapid bioassessment protocol recommended by Environmental Protection Agency (EPA) was followed utilizing Kicknet and D'net of 500μm mesh size to sample the macroinvertebrates. Family Biotic Index (FBI) calculated using the tolerance value of different taxa showed that there was remarkable variation in water quality along the stream. FBI values were around 4.1 – 5.0 in upstream reaches indication good water quality. Deterioration of water quality downstream was evidence in the FBI value of 5.3 – 5.5 in the mid reaches and 6.0 – 6.5 in the lower reaches. These values were also found to be in conformity with the water quality as assessed at the biomonitoring sites. It is thus concluded that biomonitoring is feasible in such streams in the region to obtain a quick assessment of water quality.

A similar study was conducted by Kenney et al. (2009) entitled "Benthic macroinvertebrates as indicators of water quality: The intersection of science and policy" highlighted the complex relationships between bio-assessments using stream macro-invertebrates and their relevance for developing bio-criteria, stressor identification, and classification of impaired waters. They also discuss an example of the environmental management approach, specifically, how macroinvertebrates can be used to indicate the relative success of stream restoration. For policymakers, the study serves to illuminate opportunities and limitations of using benthic macroinvertebrates as indicators of water quality. For entomologists, the study highlights policy-relevant research questions that would

further aid the classification of impaired waters, the identification of stressors, or the management of stream ecosystems.

Weeks et al. (2009) conducted a study entitled "Benthic Macroinvertebrates Bioindicators at the Kleinstuck Preserve Wetlands" where they found 21 different types of benthic macroinvertebrates that ranged from pollution sensitive organisms such as the Mayfly naiad to very pollution tollerant creatures such as the Ramshorn snail. The researchers determined and surveyed the presence of benthic macroinvertebrates at the Kleinstuck Preserve wetland in Kalamazoo, Michigan, during May 2009. Kleinstuck Preserve is comprised of stagnant water with a range of shoreline areas that are inhabited by numbers of floating and rooted grass or of leaf litter and branch debris along the marshland floor. A uniform survey method was used to sample species richness at six locations around the perimeter of the wetland. Samples were sorted within one day of collection, and were refrigerated for at least 1 hour before sorting and then sifted through. Any observable benthic macroinvertebrates were removed, identified, and species presences were recorded. Water quality was determined by a Species Richness and a Pollution Sensitivity Index based on the Missouri Department of Natural Resource's Volunteer Water Quality Rating Sheet, modified by Dr. Ann Fraser. Water quality ratings were based on a scale of poor, fair, good, very good, and excellent. Statistical significance comparing Taxa Richness of low- and high-access areas was determined using a t-test.

On the other hand, Chadde (2007) conducted a study entitled "Benthic Macroinvertebrates as indicators of stream health". It was first defined why the

macro-invertebrates can be used as an indicator of a good stream health, reasons are: they spend up to one year in the water, have little mobility, generally abundant, and good indicators of localized condition. Macro-invertebrates are sensitive to sedimentation, habitat loss, and chemical pollution. There are three (3) categories of stream macro-invertebrates. Group one which is are pollution sensitive and requires high Dissolve Oxygen (DO), Neutral pH, and Cold water. Examples are Mayflies, Stoneflies, and Caddisflies. Group 2 are somewhat pollution tolerant; species includes Dragonflies, Damselflies, and Scuds. Group 3 are pollution tolerant, includes aquatic worms and midge larvae. The Macro-invertebrates are biological measures that can provide a much integrated and comprehensive assessment of the health of a waterbody over time.

In relation to water quality, Maglangit et al. (2014) conducted a study entitled "Physicochemical-assessment of the Water Quality of Buhisan River, Cebu, Philippines". The study carried out to assess and provide baseline data on the water quality of Buhisan River, Cebu. Water samples were taken in the upstream, midstream and downstream sites of Buhisan River every month from November 2011 to April 2012. The parameters measured on-site were temperature, pH and total dissolved solids (TDS). Laboratory analyses of total suspended solids (TSS), dissolved oxygen (DO), biochemical oxygen demand (BOD5), nitrates and total phosphorus were carried out according to APHA methods. Results of the study showed that mean midstream and downstream DO and BOD levels did not comply with the standard for Class D surface waters set by the Department of Environmental and Natural Resources (DENR). All measured parameters except for temperature vary significantly across location

($p<0.05$). The levels of BOD and DO in the midstream and downstream sites exceeded the DENR limit which is suggestive of organic pollutants from domestic sources and urban runoffs from surrounding areas. The water quality of Buhisan River must be regularly monitored to appropriate mitigating measures for the protection and preservation of this freshwater resource.

**Synthesis**

The researches and the studies reviewed and presented above are similar to this study through the use of macroinvertebrates as indicator of the state of the water bodies.

The present study and the researches presented above differs only in the location of the study, sampling techniques used, sampling period, the year, and the water body that is going to be the site of the research.

# Chapter 3

## METHODOLOGY

This chapter provides a descriptive methods and processes that were used in gathering data for the research study. It includes the materials, reagents, apparatus and other research equipment.

### 3.1 Selection of sampling location

The location of the study was chosen by the researchers because according to the local government of Brgy. Ilayang bukal, there was no record of any researches that was conducted in the site. It would be a great opportunity to conduct a baseline study in order to provide help to the local government. The sampling site is located on Talon falls in Barangay Ilayang Bukal, Tayabas, Quezon. The stations were chosen according to the levels of elevation from the spring located above the first station. The second station is located 15 meters from the first station and has a lower level of elevation and the third station is located 20 meters away from the second station and has the lowest elevation among the three. The three stations also differ in the number of people who visited the area.

### 3.2 Selection of sampling periods

The sampling periods are in the months of June, August, October, and December.

### 3.3 Sampling method

The sampling method that was used to gather water samples is grab sampling method. The samples were gathered with approximately time period of 1-2 minutes to avoid changes in the properties of water. For the collection of species of macroinvertebrates, dip net method was used three times in each station to provide more accurate count of the diversity of each species present in the falls.

### 3.4 Collection of Water Samples

The water body being monitored by the researchers is a waterfall with a spring in the upstream as identified in the Barangay Ilayang Bukal. The water that flows in the spring is distributed to different areas of the barangay. The locals used the water from the spring as a source of water for everyday living. The overflow from the spring directly falls down to the main pool which is the station 1 and distributed to several pools as it flows. Based on observation several kinds of macro-invertebrates are seen which can be used as bioindicator of the quality of water. Another observation is that during the course of four sampling periods, the three stations were inhabited by a large number of leaf litter and other plant matter and the vegetation cover of the shoreline is abundant in the months of June and December, however, in the months of August and October the vegetation cover gradually decreases. The researchers attempted to study the quality of water together with the diversity of macro-invertebrates present for four (4) monitoring periods.

**3.5 Identity of the Macro-invertebrates species found in the falls at different sampling periods.**

Macro-invertebrates were collected three times in three different stations to obtain a one large sample from June to December. Macro-invertebrates were collected using a Dip Net method and Random sampling within the stations, and all the non-macro-invertebrates was put back to the water.

From the protocols of USEPA Volunteer Stream Monitoring Methods Manual (1997), all the samples collected in a station were combined to obtain one large sample. The samples were preserved in a 70% ethanol.

**3.6 Test of water samples**

After the collection of samples, the water samples were placed on an ice chest to retain its freshness before testing. Some of the representative samples were brought to MachUnion Water Laboratory for testing and the other were brought to TUP Manila. The parameters were tested according to the following procedures:

**3.6.1 Physico-chemical Properties**

**3.6.1.1 Ammonia**

Into an Erlenmeyer flask, 100 mL sample was added 1mL of $ZnSO_4$ solution. Then the pH was adjusted to 10.5 by adding 0.5mL of 6N NaOH solution. The solution was set aside until settled then the supernatant was filtered through No. 42 Whattman filter paper. Then, 50 mL of sample was taken and 3 drops of Rochelle salt solution was added and mixed well. Then, 1mL of Nessler reagent was added and percent transmission was red at 410 nm after 10 minutes.

#### 3.6.1.2 Chloride

A 50 mL of water samples was pipetted into 3 Erlenmeyer flask. Then, 1.0 mL of $K_2CrO_4$ indicator Solution was added, then the pH was adjusted to 7-10 using 1M NaOH and lastly, it was titrated with $AgNO_3$ titrant until a pinkish yellow end point was observed.

#### 3.6.1.3 Nitrate

The analysis of nitrate in water were handled by Mach Union water Laboratory using 4500-D. Ion Selective method.

#### 3.6.1.4 Phosphate

The analysis of phosphate in water were handled by Mach Union water Laboratory using 4500-P D. Stannous chloride method.

#### 3.6.1.5 Sulfate

Into a 250 mL erlenmeyer flask a 50 mL of water sample was introduced then 10 mL of buffer solution was added and the mixture was thoroughly stirred upon the addition of a spoonful $BaCl_2$. The absorbance of the mixture at 420 nm was determined via spectronic 20 spectrophotometer. Then the concentration was determined in mg/L.

#### 3.6.1.6 Dissolve Oxygen

The cap of the DO bottle was removed and immersed beneath the water's surface. The water was allowed to overflow to ensure the elimination of bubbles. Then, 8 drops of Manganous Sulfate Solution and 8 drops of Alkaline Potassium Iodide Azide were added. The bottles were

inverted repeatedly until the floc has settled halfway. Then, 1mL of concentrated sulfuric acid was added and inverted until dissolution is complete. 200 mL of the sample were used for titration with $Na_2SO_4$ to faint yellow color and 1 mL of freshly prepared starch solution were added and titrated again with $Na_2SO_4$ until the disappearance of blue color.

**3.6.1.7 pH**

The pH was measured using a digital pH meter were it was calibrated to 7 before taking the pH of the water from the location.

**3.6.1.8 Temperature**

Using a laboratory thermometer, the temperature of the water was obtained by immersing the thermometer for three minutes in the beaker where the water sample is contained.

**3.6.1.9 Total Dissolved Solids**

The 100 mL filtrate that was initially used for the test of TSS was placed in an evaporating dish which was initially weighed and the evaporating dish was placed in a steam stove to dry the water and once dried the evaporating dish was weighed and the changes will be recorded.

**3.6.1.10 Total Suspended Solids**

A 100 mL of the water sample was filtered using the No. 42 whattman filter paper that was initially weighed and after the filtration it was placed in the furnace for a couple of hours in 75°C and weighed and placed again in the drying oven until a constant weight is obtained.

#### 3.6.1.11 Total Hardness

A 100 mL of water sample was poured into 3 Erlenmeyer flask and 2 mL of 1M HCl was added and boiled for 3 minutes and the solution was cooled to room temperature and 5 mL of buffer solution and EBT indicator was added and titrated with standard EDTA until the clear blue color settle and the hardness of water was calculated as ppm $CaCO_3$.

### 3.6.2 Microbiological Properties

#### 3.6.2.1 Total Coliform

The analysis of Total Coliform in water was handled by Mach Union water Laboratory using 9221-E Multiple Tube Fermentation method.

#### 3.6.2.2 Fecal Coliform

The analysis of Fecal Coliform in water was handled by Mach Union water Laboratory using 9221-E Multiple Tube Fermentation method.

## 3.7 Materials and Apparatus

The materials and apparatus used were Erlenmeyer flask, beakers, burettes, pipette, droppers, amber bottles, water bath, filter paper, hot plate, pH meter, graduated cylinders, volumetric flask, analytical balance, triple beam balance, evaporating dish, watch glass, aluminum foil.

EDTA reagent, NaOH, $H_2SO_4$, $Na_2S_2O_4$. Starch solution, azide reagent, manganous sulfate, EBT Indicator, Nessler Reagent, Rochelle salt, 6N NaOH, Potassium Chromate, Buffer Solution B and Ammonia Buffer Solution.

### 3.8 Interview guide

In order to know some information that are related to the Talon Falls, interview guide was made that has the intention to the gather information such as what are the purpose of Talon falls to the respondents, how frequent they visit it and how important is the falls for them. The interview guide was validated by the selected faculty member and the City Administrator of Tayabas, Quezon.

### 3.9 Use of statistical treatment

Analysis of variance was used to correlate the parameters and their corresponding result gathered from three different stations at four different sampling period, Shannon-Weiner Diversity Index and Simpson's Diversity Index were used to know what was the state of macroinvertebrates diversity within the area and Pearson Correlation was used to correlate the value of the parameters and the macroinvertebrates diversity gathered.

# CHAPTER 4

# RESULTS AND DISCUSSION

This chapter shows the results of laboratory tests on the water samples from Talon Falls located at Brgy. Ilayang Bukal, Tayabas, Quezon in sampling periods of June, August, October and December 2015 and together with the diversity of macro-invertebrates and the results of interview with the residents of the said barangay that was randomly selected and analyzed in order to determine the importance of the said water body to the locality.

## 4.1 Water Quality of Talon Falls

The water that flows down the pools of Talon Falls comes from the spring in the upper part of the said falls. The spring is the primary water sources for the barangay for their daily consumption (e.g drinking, cooking, household purposes etc.). The water in the three different pools was tested in order to determine if it conforms to the limits set by DENR Administrative Order 34-1990 for Class AA waters or waters having watershed or uninhabited and requires an approved disinfection to meet the Philippines National Standards for Drinking Water (PNSDW).

Table 1 shows the physico-chemical properties of water from three sampling stations at four sampling periods.

**Table 1. Physico-chemical properties of water from three sampling stations at four sampling periods.**

| Properties | Months | Stn. 1 | Stn. 2 | Stn. 3 | DENR Limit | Remarks |
|---|---|---|---|---|---|---|
| **Ammonia, mg/L** | June | 0.001 | 0.001 | 0.001 | ----- | NA |
| | August | 0.001 | 0.001 | 0.001 | | |
| | October | 0.001 | 0.001 | 0.001 | | |
| | December | 0.001 | 0.001 | 0.001 | | |
| **Chloride, mg/L** | June | 2 | 3 | 3 | 250 | Within |
| | August | 8.61 | 13.14 | 14.5 | | Within |
| | October | 6.8 | 7.25 | 7.25 | | Within |
| | December | 8 | 5 | 2 | | Within |
| **Nitrate, mg/L** | June | 0.262 | 0.231 | 0.206 | 1.0 | Within |
| | August | 0.246 | 0.233 | 0.215 | | Within |
| | October | 0.084 | 0.211 | 0.218 | | Within |
| | December | 0.175 | 0.744 | 0.156 | | Within |
| **Phosphate, mg/L** | June | 0.097 | 0.07 | 0.086 | nil | Within |
| | August | 0.091 | 0.066 | 0.065 | | Within |
| | October | 0.084 | 0.101 | 0.079 | | Within |
| | December | 0.152 | 0.023 | 0.02 | | Within |
| **Sulfate, mg/L** | June | 12.6 | 11.5 | 13 | ------ | NA |
| | August | 24.3 | 19.26 | 21.39 | | |
| | October | 20.3 | 25.9 | 26.8 | | |
| | December | 28.5 | 31.3 | 40.6 | | |
| **Dissolved Oxygen, mg/L** | June | 9.2 | 9.8 | 9.3 | 5.0 at minimum | Within |
| | August | 12.23 | 12.4 | 12.2 | | Within |
| | October | 9.1 | 9.9 | 9.5 | | Within |
| | December | 9 | 9 | 9 | | Within |
| **pH** | June | 5.5 | 5.5 | 5.5 | 6.5-8.5 | Against |
| | August | 5.96 | 6.1 | 6.36 | | Against |
| | October | 6.3 | 6.4 | 6.6 | | Against |
| | December | 6.6 | 6.8 | 6.8 | | Within |
| **Temperature, °C** | June | 17 | 17.2 | 16.9 | ----- | NA |
| | August | 20.1 | 20.2 | 21 | | |
| | October | 20.3 | 20.3 | 20.6 | | |
| | December | 18 | 17.6 | 18 | | |
| **Total Dissolved Solids, mg/L** | June | 116 | 103 | 119 | 500 | Within |
| | August | 111 | 101 | 120 | | Within |
| | October | 121 | 125 | 115 | | Within |
| | December | 108 | 153 | 153 | | Within |
| **Total Suspended Solids, mg/L** | June | 3 | 5 | 3 | 25 | Within |
| | August | 2 | 5 | 3 | | Within |
| | October | 8 | 13 | 12 | | Within |
| | December | 8 | 16 | 16 | | Within |
| **Hardness, mg/L** | June | nil | nil | nil | ----- | NA |
| | August | nil | nil | nil | | |
| | October | nil | nil | nil | | |
| | December | nil | nil | nil | | |

**Remarks** Results are means of three trials.
nil – extremely low on concentration and not detectable by existing equipment/method.
----- - no value assigned.

The amount of Ammonia in all stations has a stable value which is less than 0.001 mg/L. The minimal amount of ammonia in the three stations can be caused by atmospheric deposition where ammonia derived from combustion processes or burning of municipal waste goes directly to the water via rainfall. In terms of Chloride, the trend rises up to 15 ppm during the month of August while the amount decreases in the month of December. The chloride present in water may come from the reaction of hydrochloric acid in the atmosphere reacting with any metals in water which is the natural source of chloride in water (EnviroSci, 2011). Nitrate in water in all sites in all sampling periods is less than 1 ppm which conforms to the standards set by the DENR for Class AA waters. Nitrates enter the water from the atmosphere, which carries nitrogen-containing compounds derived from automobiles and other sources (USGS, 2016) that causes the trace amounts or the less than 1 ppm nitrate in water samples. Phosphates in water in all stations and sampling period have a level of less than 1 mg/L. Phosphorus occurs naturally in rocks and other mineral deposits. During the natural process of weathering, the rocks gradually release the phosphorus as phosphate ions which are soluble in water and the mineralize phosphate compounds breakdown (WRC, 2014). This natural phenomenon's can be the primary reason for the small amount of phosphate in water. Sulfate level during the months of June to October ranges from 11 to 26 ppm, while in the month of December it reaches 40 ppm. The high amount of sulfate in water in the month of December can be associated to heavy rainfall (Appendix G) during the said month since sulfate is one of the major dissolved components of rain (Lenntech, 2005). In the months of June, October and December, the average values obtained from the stations 1, 2, and 3

are 9.4, 9.5 and 9 which is lower compared in the month of August where the mean values for the three stations are 12.23, 12.4 and 12.2. The high amount of dissolved oxygen during the month of August can be associated to the flow of water since the water from three stations has high velocity compared to the three sampling periods. The amount of Total Dissolved Solids and Total Suspended Solids greatly increases in stations 2 and 3 since a typhoon is present in the province and a heavy rainfall was experienced during the time of collection (Appendix G). Both stations have turbid water since a runoff from the cliff goes in both stations. Station 1 does not seem to be affected because it is the main pool from Talon Falls and it also has a meter deep compared to the remaining stations where the water level is deep up to knee level. The pH of water from three different stations at four different sampling periods ranges from 5.5 to 6.9. The acidic pH is lower compared to general pH of water surrounded by watersheds which is 6.5 – 8.5 (DAO 34). The amount of acid precipitation in the watershed can cause the pH to change. The Temperature during the first and last month ranges from 17-18 while the temperature during the August and October ranges from 20 – 21. The difference in the temperature can be associated to the rainfall and the time in-situ water quality monitoring. The hardness of water has a value of “nil” since upon adding the EBT indicator, the solution turns to blue which is rather darker than the color produced by distilled water. As per DENR Administrative Order, the water should pass the standard limits stated for the Class AA waters or waters having watersheds or protected areas. The parameters that passed the standards are Chloride, Nitrate, Dissolved Oxygen, Total Dissolved Solids, and Total Suspended Solids. The parameter which does not

conform to the standards is the pH. The other parameter such as Ammonia, Phosphates, Sulfates, Temperature and Hardness is undetermined since there is no specific standard set for the said class.

**Table 2. Microbiological Properties of water from three sampling stations at four sampling periods.**

| Properties | Months | Stn. 1 | Stn. 2 | Stn. 3 | DENR limit | Remarks |
|---|---|---|---|---|---|---|
| Total Coliform, MPN / 100 mL | June | 1300 | 4000 | 6000 | 50 MPN/ 100mL | Against |
| | August | 16000 | 3500 | 7900 | | Against |
| | October | 35000 | 2000 | 1400 | | Against |
| | December | 313 | 130000 | 54000 | | Against |
| Fecal Coliform, MPN / 100 mL | June | 30 | 700 | 5000 | 20 MPN/ 100mL | Against |
| | August | 2000 | 330 | 7900 | | Against |
| | October | 35000 | 130 | 190 | | Against |
| | December | 170 | 79000 | 54000 | | Against |

**Remarks** Results given are the highest value from each trial.

Table 2 shows the highest value of the Total Coliform and Fecal Coliform test which are done by a licensed laboratory using multiple tube fermentation technique. The highest value was used since it is the most probable content of the water sample. The high results of total coliform during the sampling periods can be associated to the bacteria that can be found in soil and water and since the water bed is primarily made of soil it can affect the level of total coliform in the water. As per Fecal coliform, it is lower than the total coliform, it could be caused by the feces of warm blooded animals from days before the sampling period since the area is a watershed. Both bacteriological properties are against the standards set by the DAO 34 for Class AA waters (Appendix E).

## 4.2 Statistical Analysis

Analysis of Variance was used to determine if there are significant differences among the physico-chemical properties of water in three sampling stations and in four sampling periods.

**Table 3. Results of the analysis of variance for physico-chemical properties of water among the three sampling station in four sampling periods.**

| Properties | JUNE | | AUGUST | | OCTOBER | | DECEMBER | |
|---|---|---|---|---|---|---|---|---|
| | f-value | Remarks | f-value | Remarks | f-value | Remarks | f-value | Remarks |
| **Chloride** | | | 9.418 | Not Significant | 0.208 | Not Significant | 25 | Significant |
| **Phosphate** | | | 1.805 | Not Significant | 0.142 | Not Significant | 1018 | Significant |
| **Nitrate** | 41 | Significant | 13 | Significant | 155 | Significant | 851 | Significant |
| **Sulfate** | 13 | Significant | 426 | Significant | 974 | Significant | 1837 | Significant |
| **Dissolved Oxygen** | | | 0.145 | Not Significant | 90 | Significant | 0.273 | Not Significant |
| **Total Dissolved Solids** | | | 27 | Significant | 0.509 | Not Significant | 12 | Significant |
| **Total Suspended Solids** | | | 52 | Significant | 4.173 | Not Significant | 14 | Significant |

Remarks F crit. = 10.92

Table 3 shows that in the month of June, Nitrate and Sulfate differ significantly in three sampling stations. The other property which does not have an f-value has a result of means of three trials and ANOVAs was not performed for those properties. In the month of August, chloride, phosphate and dissolved oxygen do not differ significantly. The nitrate, sulfate, total dissolved solids and total suspended solids have significant differences. In the month of October, chloride, phosphate, dissolved solids and suspended solids do not have significant differences and the nitrate and sulfate and dissolved oxygen varies significantly. In the months of December dissolved oxygen is the only property of water that does not have significant difference since the value obtained from the tests has a

precision and the rest has significant differences because of the weak precision upon the results obtained.

**Table 4. Results of the analysis of variance for physico-chemical properties of water among the four sampling periods in three sampling stations.**

| Properties | Station 1 | | Station 2 | | Station 3 | |
|---|---|---|---|---|---|---|
| | f-value | Remarks | f-value | Remarks | f-value | Remarks |
| **Chloride** | 0.0786 | Not Significant | 0.2665 | Not Significant | 0.501 | Not Significant |
| **Phosphate** | 0.0681 | Not Significant | 0.1027 | Not Significant | 0.6624 | Not Significant |
| **Nitrate** | 0.1807 | Not Significant | 0.527 | Not Significant | 0.0214 | Not Significant |
| **Sulfate** | 0.0681 | Not Significant | 0.1027 | Not Significant | 0.1385 | Not Significant |
| **Dissolved Oxygen** | 0.0239 | Not Significant | 0.0205 | Not Significant | 0.6826 | Not Significant |
| **Total Dissolved Solids** | 0.1094 | Not Significant | 0.1635 | Not Significant | 0.1375 | Not Significant |
| **Total Suspended Solids** | 0.2559 | Not Significant | 0.2379 | Not Significant | 0.4019 | Not Significant |
| Remarks | F - Crit. = 8.02 | | | | | |

The table 4 shows the Analysis of Variance of physico-chemical properties of the water among the three stations in four sampling periods. All of the properties from the three stations do not differ significantly from each other.

### 4.3 Diversity of the location

Freshwater community is home to a number of many different organisms such as freshwater crustacean, aquatic insects, mollusks and different type of vegetation. In order to determine the health condition of the water body, it is best to use the species present to determine its overall condition.

In each sampling period, the diversity of the stations was quantified using dip-net method and random sampling. The sampling was done in three trials and combined to have a larger sample. The species were counted and released back to the water after the sampling.

**Table 5. Diversity of Macro-invertebrates in three sampling stations using Diversity Indices**

| Station Number | Simpson's Diversity Index | | | | Shannon's Diversity Index | | | |
|---|---|---|---|---|---|---|---|---|
| | Jun. | Aug. | Oct. | Dec. | Jun. | Aug. | Oct. | Dec. |
| 1 | 0.21 | 0.12 | 0.09 | 0.55 | 0.31 | 0.16 | 0.13 | 0.58 |
| 2 | 0.48 | 0.40 | 0.64 | 0.63 | 0.16 | 0.42 | 0.03 | 0.66 |
| 3 | 0.62 | 0.52 | 0.41 | 0.75 | 0.83 | 0.62 | 0.55 | 0.82 |

Table 5 shows the results of Diversity indices. Simpson's Diversity index shows that all values are below 1. Closeness of the diversity to 1 indicates a less diversity and based on the computed data, there is a high diversity of macroinvertebrates during the four sampling periods in three different stations because all values are close to 0.

The computed values of Shannon's Diversity Index present a low species evenness. Closeness of computed data to 3.5 indicates high species evenness and based on the data, the three stations do not have high species evenness since the *Caridina sp.* dominantly thrives in the stations. High Species richness can be attained if all the species do not overpower other populations.

### 4.4 Macroinvertebrates as Indicator of water quality

Macroinvertebrates are indicators of water quality. Different types of macroinvertebrates tolerate different stream conditions and levels of pollution.

Depending on the types of macroinvertebrates found in a stream, predictions about water quality can be made. For example, caddisflies, mayflies, and stoneflies cannot live in polluted water. If these bugs are found in a stream, the water quality there is probably good. A different station from the location varies on the abundance of the species present in the area (Utah State University Extension, 2011). Macroinvertebrates are useful to sample in a stream when monitoring water quality because these organisms are easy to collect and identify, and tend to stay in one area unless environmental conditions change. Some macroinvertebrates are highly sensitive to pollution, while others tolerate it. Table 6 below shows the species in family level and grouped according to their sensitivity to pollution (Science Olympiad Student Center Wiki, 2015).

**Table 6. Classification of Macro-invertebrates according to their sensitivity to pollution.**

| Class 1 Pollution Sensitive | Class 2 Moderately Sensitive | Class 3 Moderately Tolerant | Class 4 Pollution Tolerant | Class 5 Air Breathing |
|---|---|---|---|---|
| Leptoceridae | Calopterygidae | Potamidae | Thiaridae | Notonectidae |
| Heptageniidae | Atyidae | | | Dysticidae |
| Gilled snails | | | | Gyrinidae |
| Perlolidae | | | | Gerridae |
| | | | | Veliidae |
| | | | | Pisauridae |

Aquatic Insects can be grouped according to their indicator value or how sensitive the species is. Table 6 shows that most of the insects identified are Air Breathing and do not really get affected by the water. Pollution tolerant species like Thiaridae or commonly known as Trumpet Snail are present in the station 1 and 2 in different months. Although they can be both present in a clean water system and degraded water, high number of this species could indicate rising pollution levels. The Potamidae or the Freshwater crab is assigned to moderately

tolerant since high level of pollution cannot be handled by the freshwater crustaceans. Fresh water shrimps indicate clean water (BBC, 2014) thus the Atyidae is considered moderately sensitive to pollution. The pollution sensitive organisms such as Heptageniidae, Leptoceridae, and Gilled Snails can be primarily found in station 2 since it has shallow water that is suitable for aquatic insects. Perlolidae can only be found in station 1 since nymph of Stoneflies generally occur in clear cool, running waters at high altitudes, sometimes being found on the edges of lakes at the point of inflow (The Murray-Darling Freshwater Research Centre). The distribution of macro-invertebrates present in the station 2 is higher compared to stations 1 and 3 (See Appendix F).

**4.5 Responses and Perception of the locale in the interview**

The table 7 below shows the results of the interview that was conducted on the community of Brgy. Ilayang Bukal, Tayabas, Quezon. This includes the percentage of the answer of the correspondents on a given question related to the Talon Falls.

**Table 7. Responses of the community to the interview conducted**

| Question | Yes | No |
|---|---|---|
| Are you familiar with the "Talon" falls found in Brgy. Ilayang Bukal? | 66 (100%) | 0 |
| Have you gone to the place? | 64 (96%) | 2 (4%) |
| Are you aware of the ways of preserving the environment? | 63 (95%) | 3 (5%) |
| Are there any programs or ordinances of the barangay in protecting the falls from destruction? | 66 (100%) | 0 |

Based on the answers of the locales they are all familiar with the falls because most of them are born within the barangay where the falls is located

while some know the falls because they have partners that reside within the barangay and it is sometimes their topic. In connection to this, 96% of the respondents said that they go to the falls once a year specifically on the season of holy week. Most people do not go to the location unless there are maintenance works that must be done in relation to the water supply. All of the respondents said that they all use the water from the falls for their household chores, cooking and drinking but they rarely use the water from the pools of the falls for anything. Base on the results of the interview to the locales most of them know some ways on how to preserve or protect the environment specifically the falls such as they should not litter or leave trashes when they dessert the area and placing the trash on the trash bin. We also had the chance to interview some of the barangay officials and they share some of the ordinances that the barangay have such as they should not litter, no illegal logging should be permitted near the water source and they should always clean the surroundings. When we ask them if the falls is important to them and how important it is they answered without hesitating that the falls is very important and they do everything just to protect it.

Additional fact concerning the falls were also shared to us by some of the locales specifically the elderly that there was a time that one private person wanted to have a water connection from the falls to the subdivision he was building that time but the barangay captain and the locales did not agree to the plan because they are afraid that if that plan happened there will be water shortage in their barangay.

# Chapter 5

# SUMMARY, CONCLUSION AND RECOMMENDATIONS

This chapter presents the summary of the study as well as the recommendations that can be helpful to other researchers who will conduct similar study. The summary of the study comprises the diversity of macro-invertebrates, physico- chemical and biological characteristics of the water from the falls

## 5.1 SUMMARY

The study aimed to perform assessment of macro-invertebrates and water quality through physico-chemical and microbiological properties of the water. Specifically to determine (1) the physico- chemical properties of water in terms of Ammonia, Chloride, Phosphate, Nitrate, Sulfate, Dissolve Oxygen, pH, Temperature, Total Dissolved Solids, Total Suspended Solids, Total Hardness, (2) microbiological properties in terms of Total Coliform and Fecal coliform, (3) determine whether there are significant differences among the physico-chemical and microbiological parameters (4) determine the species of macro-invertebrates present in the area (5) to classify the macro-invertebrates as bio-indicators (6) determine the species diversity using Simpson and Shannon-Weiner diversity index (7) and usage of interview questionnaire.

The study was done in three sampling stations of Talon falls located at Brgy. Ilayang Bukal, Tayabas, Quezon. The first station was located near the spring, the second station was chosen because it is where most of the visitors of the falls eat and stay, the third station was almost 40 meters from the first station.

The residents were asked about the relevance of the falls to the locale, their awareness to it and the activities that they are doing in the location. Collection of water samples was done during the months of June, August, October, and December. Grab sampling was used to collect water samples from each stations. Dip-net method and random sampling were used to collect the macro-invertebrates.

## 5.2 CONCLUSION

Base on the result of the study, the following conclusions were drawn:

1. there are no significant differences in the physico-chemical properties of water in Talon fall at four sampling periods in three sampling stations.

2. there are significant differences among the three station of Talon falls in terms of nitrate and sulfate in the month of June; nitrate, total dissolved solids and total suspended solids in the month of August; nitrate, sulfate and dissolved oxygen in the month of October; chloride, phosphate, nitrate, sulfate, total dissolved solids and total suspended solids in the months of December.

## 5.3 Recommendations

Based on the findings of the study, the following recommendations are made:

1. Monthly monitoring on the potability of water coming from the spring or the water source of the barangay.
2. Identify the important flora and fauna species present in the area.

# Appendix A
# Sampling Site and Stations



**Fig. 3** Station One



**Fig. 4** Station Two



**Fig.6** Dip Net Sampling




**Fig.7** Water samples in DO Bottles to be preserved

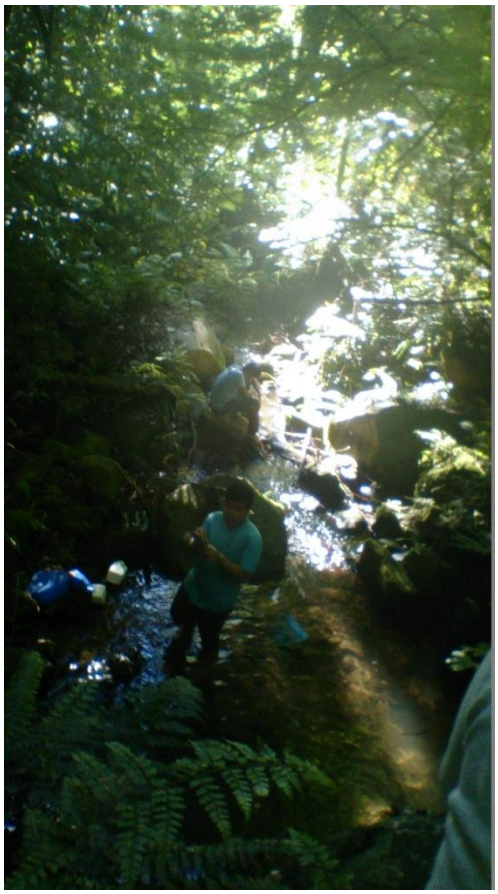


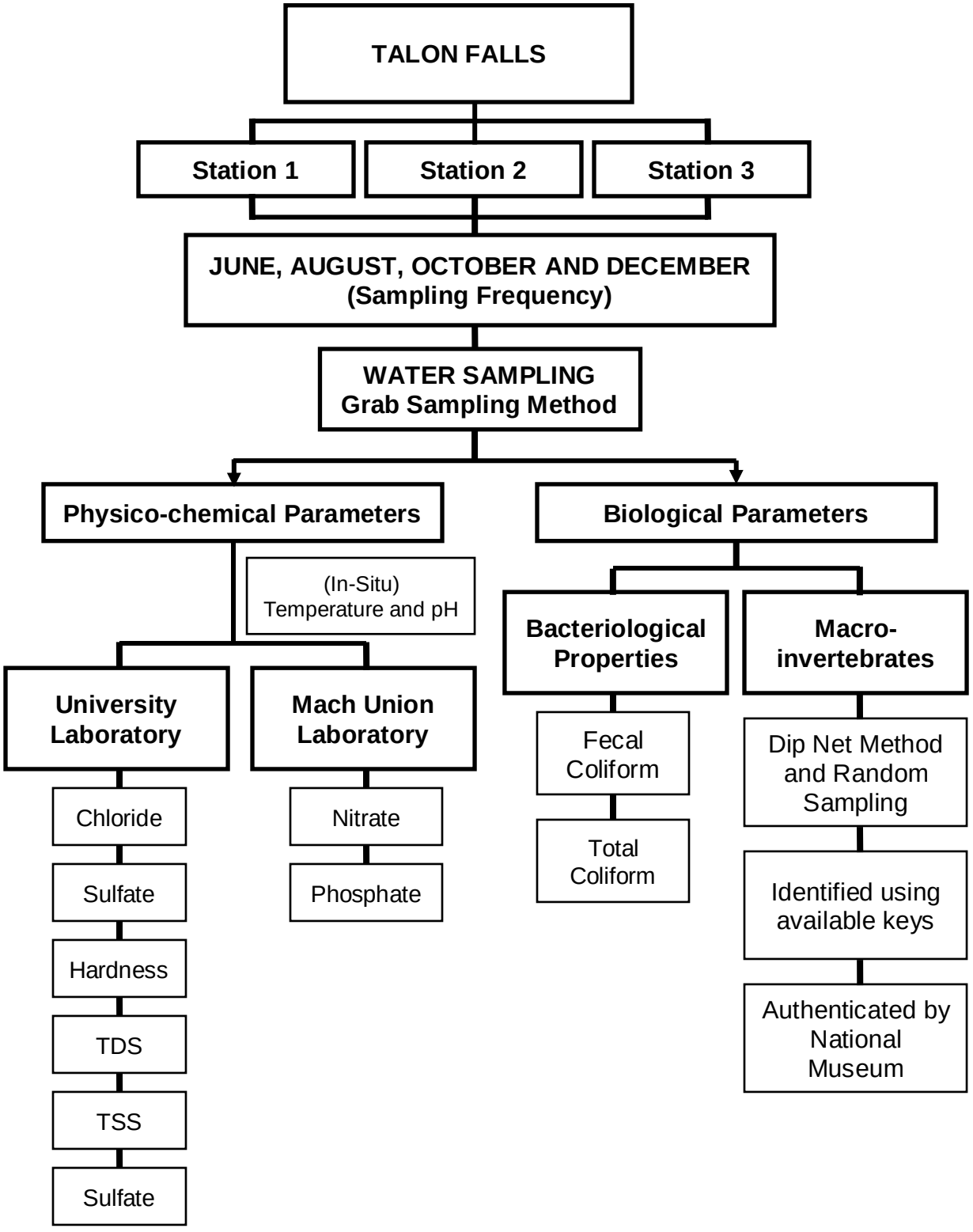
**Fig.5** Station Three



**Fig. 8** Common spot where visitors could sit and relax

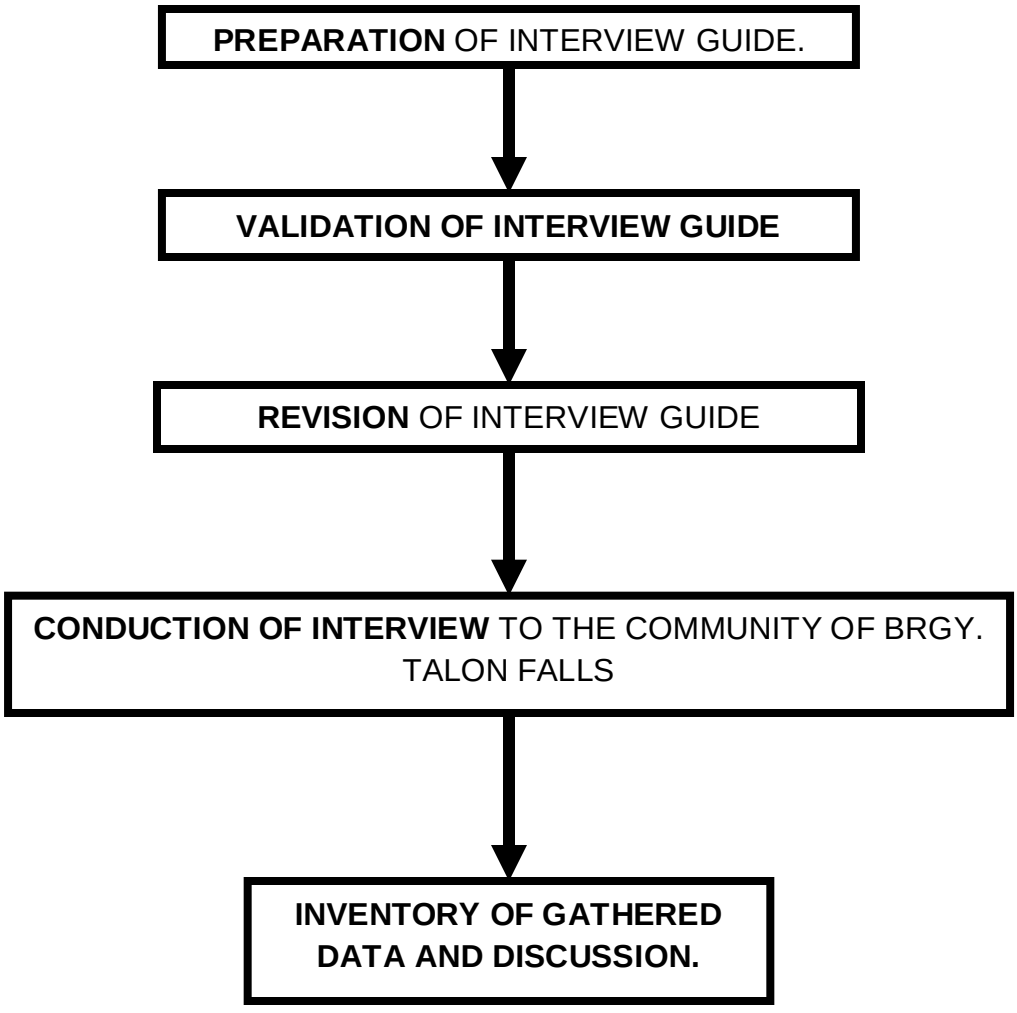
# Appendix B
# Schematic Diagram

**Water and Macro-invertebrates Collection**




.

**INTERVIEW GUIDE**



# Appendix C
# Interview Questionnaire

# Interview Questionnaire Guide

**Demographic Profile**

Name:_____ Status:_____ Sex:____

Age:___ Occupation:_____

Number of Years in the Area:____

1. Are you familiar with the "Talon" falls found in Brgy. Ilayang Bukal? Yes__ No__

   (*Pamilyar ka ba sa talon?*) *Oo___ Hindi___*

2. Have you gone to the place? : Yes__ No__

   (*Nakapunta ka na ba sa lugar?*) *Oo___ Hindi___*

   If yes, how often? :

   (*Kung oo, gaano kadalas*)

3. For what purpose are you using the water from the falls? :

   (*Sa paanong paraan ninyo ginagamit ang tubig mula sa talon?*)

4. Are you aware of the ways of preserving the environment? : Yes__ No__

   (*Mayroon ka bang kamalayan kung paano pag iingatan ang ating kapaligiran?*)

   *Oo___ Hindi___*

   If yes, cite an example:

   (*Kung oo, mag bigay ng halimbawa*)

5. Are there any programs or ordinances of the barangay in protecting the falls from destruction? Yes__ No__

(*Mayroon ka bang alam na programa o ordinansa ng barangay para sa maayos na paggamit ng talon?*) *Oo___ Hindi___*

If yes, kindly answer the following questions:

(*Kung oo, anu-ano ang mga ito?*):

Are these programs or ordinances implemented properly?

(*Sa iyong kaalaman, Naipatutupad ba ng maayos ang mga programa o ordinansang ito?*)

6. How important is the falls to you?
   (*Gaano kahalaga ang talon para sayo?)*

# Appendix D
# Water Quality Criteria

**Table 1 – Water Quality Criteria for Conventional and Other Pollutants Contributing to Aesthetics and Oxygen Demand for Fresh Waters [a]**

| PARAMETER | UNIT | CLASS AA | CLASS A | CLASS B | CLASS C | CLASS D [b] |
|---|---|---|---|---|---|---|
| Color | PCU | 15 | 50 | (c) | (c) | (c) |
| Temperature [d] (max. rise in deg. Celcius) | °C rise | | 3 | 3 | 3 | 3 |
| pH (range) | | 6.5 - 8.5 | 6.5 - 8.5 | 6.5 - 8.5 | 6.5 - 8.5 | 6.0 - 9.0 |
| Dissolved Oxygen [e] (Minimum) | % satn<br>mg/L | 70<br>5.0 | 70<br>5.0 | 70<br>5.0 | 60<br>5.0 | 40<br>3.0 |
| 5-Day 20°C BOD | mg/L | 1 | 5 | 5 | 7(10) | 10(15) |
| Total Suspended Solids | mg/L | 25 | 50 | [f] | [g] | [h] |
| Total Dissolved Solids | mg/L | 500 [i] | 1,000 [i] | - | - | 1,000 [i] |
| Surfactants (MBAS) | mg/L | nil | 0.2(0.5) | 0.3(0.5) | 0.5 | - |
| Oil/Grease (Petroleum Ether Extracts) | mg/L | nil | 1 | 1 | 2 | 5 |
| Nitrate as Nitrogen | mg/L | 1.0 | 10 | nr | 10[j] | - |
| Phosphate as Phosphorus | mg/L | nil | 0.1[k] | 0.2[k] | 0.4[k] | - |
| Phenolic Substances as Phenols | mg/L | nil | 0.002 | 0.005[l] | 0.02[l] | - |
| Total Coliforms | MPN/ 100 mL | 50[m] | 1,000[m] | 1,000[m] | 5,000[m] | - |
| Or Fecal Coliforms | MPN/ 100 mL | 20[m] | 100[m] | 200[m] | - | - |
| Chloride as Cl | mg/L | 250 | 250 | - | 350 | - |
| Copper | mg/L | 1.0 | 1.0 | - | 0.05[c] | - |

Footnotes for Tables 1

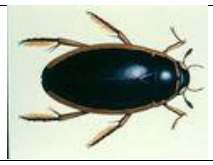
(a) - Except as otherwise indicated, the numerical limits in Tables 1 and 3 are yearly average values. Values enclosed in parentheses are maximum values.
(b) - For irrigation purposes, **SAR** should have a minimum value of 8 and a maximum value not to exceed 18. **Boron** should not exceed 0.75 mg/L.
(c) - No abnormal discoloration from unnatural causes
(d) - The allowable temperature increase over the average ambient temperature for each month. This rise shall be based on the average of the maximum daily temperature

readings recorded at the site but upstream of the mixing zone over a period of one (1) month.

(e) - Sampling taken between 9:00 AM and 4:00 PM
(f) - Not more than 30% increase
(g) - Not more than 30 mg/L increase
(h) - Not more than 60 mg/L increase
(i) - Do not apply if natural background is higher in concentration. The latter will prevail and will be used as baseline
(j) - Applicable only to lakes or reservoirs, and similarly impounded water
(k) - When applied to lakes or reservoirs, the **Phosphate as P** concentration should not exceed an average of 0.05 mg/L nor a maximum of 0.1 mg/L
(l) - Not present in concentrations to affect fish flavor/taste
(m) - These values refer to the geometric mean of the most probable number of coliform organism during a 3-month period and that the limit indicated shall not be exceeded in 20 percent of the samples taken during the same period
(n) - For spawning areas for Chanoschanos and other similar species
(o) - Limit is in terms of **dissolved copper**
nil - Extremely low concentration and not detectable by existing equipment
--- - Means the standard of these substances are not considered necessary for the present time, considering the stage of the country's development and DENR capabilities, equipment and resources
nr - Means No Recommendation made

# Appendix E
# Macro-organisms Classification
# As Indicators

| | | |
|---|---|---|
| **Class 1 - Pollution Sensitive** | | |
| | | Importance as Indicators |
| 1 | Mayfly | Mayflies prefer cleaner water; therefore their presence indicates clean water sources. |
| 2 | Caddisfly | Different species indicate varying levels of pollution. |
| 3 | Stonefly | Indicate fast-moving clean water with much oxygen. |
| 4 | Dobsonfly | Dobsonflies are only present in very clean environments because they are intolerant of pollution. |
| 5 | Gilled Snails | Cannot tolerate pollution as they need oxygen rich water |
| 6 | Water Penny | Indicate much oxygen and fast-moving waters |
| 7 | Riffle Beetle | Indicate clean, oxygen rich, fast-moving bodies of water |
| 8 | Water Scorpion | Indicate slow moving bodies of water. Usually found in areas with little vegetation |
| **Class 2 - Moderately Sensitive** | | |
| 9 | Damselfly | Indicate slow moving water, such as streams, ponds, or lakes. |
| 10 | Dragonfly | Indicates slow moving water, such as streams, ponds, or lakes. |
| 11 | Aquatic Sowbug | Can cope with organic waste, indicating streams that are beginning to recover from sewage pollution |
| 12 | Scuds | Indicate calcium and nutrient-rich water clear of sediments and pollution |
| 13 | Cranefly | Indicate very clean water |
| **Class 3 – Moderately Tolerant** | | |
| 14 | Water Mite | Open, clean water, sometimes found in pool bottoms |
| 15 | Midge | Indicate poor water quality and are tolerant of pollution |
| 16 | Blackfly | Indicate swift-flowing water and too many nutrients. |
| 17 | Flatworm | Indicate poor water quality. |
| 18 | Leeches | Indicate running water of very poor quality. |
| **Class 4 – Pollution Tolerant** | | |
| 19 | Air Breating Snail | Indicate nutrient enriched conditions and poor water quality. |
| 20 | Deer Fly | Tolerant to pollution and found in areas of slow moving water |
| 21 | Horse Fly | Horsefly larvae are moderately to very tolerant of pollution. They are generally found in slow-moving waters, though not always. |
| 22 | Tubifex | Tubifex are considered pollution-tolerant. They are generally found in stagnant water with soft mud bottoms. High numbers are considered indicators of very poor water quality. They can survive in water more polluted and oxygen deprived than almost any other species. |
| 23 | Blood Midge | Because blood midge larvae have a lot of hemoglobin, they are better able to survive in low-oxygen, nutrient-rich water. They are classified as pollution-tolerant. They are the most common midge indicators, because they best indicate poor water quality. |
| **Class 5 – Air Breathing** | | |
| 24 | Whirligig Beetle | Large numbers of whirligig beetles can indicate moderate water quality. They are classified as air-breathing since they do not rely on underwater oxygen content. |
| 25 | Water Strider | Water striders are air breathing. Large numbers can indicate moderate or slightly polluted water quality. |
| 26 | Mosquito | Mosquitoes are generally not a good water quality indicator, but their larvae are only found in stagnant water. Some larvae can survive in very poor-quality or acidic water. |
| 27 | Giant Water Bug | Giant water bugs are air-breathing. They prefer clear water with aquatic vegetation. |
| 28 | Back Swimmer | Backswimmers are air-breathing, so they exist under a wide range of water quality conditions including polluted waters. Their presence alone can indicate polluted water. |
| 29 | Water Boatman | Like other air-breathing macroinvertebrates, water boatmen have a wide range of pollution-tolerance. Some are highly tolerant of water pollution. |
| 30 | Predacious Diving Beetle | They are classified as air breathing, but some consider it to be sensitive to pollution and an indicator of good water quality. Larvae do breathe underwater, so they need oxygen. |

| | | | | | |
|---|---|---|---|---|---|
| 1 |  | 11 |  | 21 |  |
| 2 |  | 12 |  | 22 |  |
| 3 |  | 13 |  | 23 |  |
| 4 |  | 14 |  | 24 |  |
| 5 |  | 15 |  | 25 |  |
| 6 |  | 16 |  | 26 |  |
| 7 |  | 17 |  | 27 |  |
| 8 |  | 18 |  | 28 |  |
| 9 |  | 19 |  | 29 |  |
| 10 |  | 20 |  | 30 |  |

# Appendix F
# Identity and Distribution of Macro-invertebrates per site

Table 8. Identity and Distribution of Macro-invertebrates per station.

| Class | Family | Genus | Species | June | | | August | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Station 1 | Station 2 | Station 3 | Station 1 | Station 2 | Station 3 |
| Insecta | Dysticidae | | | 0 | 0 | 0 | 0 | 12 | 0 |
| | Calopterygidae | | | 0 | 0 | 0 | 0 | 0 | 0 |
| | Gerridae | | | 0 | 6 | 7 | 12 | 9 | 1 |
| | Gyrinidae | | | 6 | 12 | 22 | 1 | 15 | 12 |
| | Heptageniidae | | | 2 | 0 | 0 | 6 | 23 | 0 |
| | Limnephilidae | | | 0 | 0 | 0 | 0 | 5 | 9 |
| | Notonectidae | | | 2 | 8 | 0 | 0 | 8 | 8 |
| | Perlolidae | | | 0 | 0 | 0 | 3 | 0 | 0 |
| | Veliidae | *Rhagovelia* | | 8 | 4 | 16 | 12 | 8 | 12 |
| Malacostraca | Atyidae | *Caridina* | *sp.* | 137 | 83 | 52 | 585 | 296 | 86 |
| | Parathelphusidae | *Sundathelphusa* | *sp.* | 0 | 2 | 0 | 0 | 4 | 0 |
| Arachnida | Pisauridae | | | 0 | 0 | 0 | 0 | 1 | 0 |
| Gastropoda | Thiaridae | *Melanoides* | *Melanoides tuberculata* | 0 | 2 | 0 | 2 | 2 | 0 |
| | Gilled Snails | | | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total Number of Macroinvertebrates** | | | | **155** | **117** | **97** | **621** | **383** | **128** |
| **Total Number of Species** | | | | **5** | **7** | **4** | **7** | **11** | **6** |

| Class | Family | Genus | Species | October | | | Decemeber | | |
|---|---|---|---|---|---|---|---|---|---|
| | | | | Station 1 | Station 2 | Station 3 | Station 1 | Station 2 | Station 3 |
| Insecta | Dysticidae | | | 0 | 6 | 2 | 0 | 0 | 0 |
| | Calopterygidae | | | 0 | 2 | 0 | 0 | 0 | 0 |
| | Gerridae | | | 6 | 14 | 8 | 3 | 2 | 2 |
| | Gyrinidae | | | 8 | 19 | 16 | 12 | 0 | 15 |
| | Heptageniidae | | | 4 | 23 | 0 | 0 | 12 | 0 |
| | Limnephilidae | | | 0 | 8 | 6 | 0 | 5 | 6 |
| | Notonectidae | | | 0 | 6 | 0 | 0 | 3 | 0 |
| | Perlolidae | | | 2 | 0 | 0 | 4 | 0 | 0 |
| | Veliidae | *Rhagovelia* | | 2 | 17 | 7 | 5 | 3 | 3 |
| Malacostraca | Atyidae | *Caridina* | *sp.* | 539 | 146 | 124 | 45 | 48 | 10 |
| | Parathelphusidae | *Sundathelphusa* | *sp.* | 3 | 2 | 0 | 0 | 4 | 0 |
| Arachnida | Pisauridae | | | 0 | 2 | 0 | 0 | 1 | 0 |
| Gastropoda | Thiaridae | *Melanoides* | *Melanoides tuberculata* | 1 | 3 | 0 | 1 | 4 | 1 |
| | Gilled Snails | | | 0 | 2 | 0 | 0 | 0 | 0 |
| **Total Number of Macroinvertebrates** | | | | **565** | **250** | **163** | **70** | **82** | **37** |
| **Total Number of Species** | | | | **8** | **13** | **6** | **6** | **9** | **6** |

# Appendix G
# PAG-ASA Rainfall Record

| JUNE 2015 | Rainfall Amount (millimeters) | |
|---|---|---|
| 1 | 9.0 | light rain |
| 2 | 0 | |
| 3 | 9999 | light rainshowers |
| 4 | 0 | |
| 5 | 7.5 | moderate rain |
| 6 | 2.5 | light rain |
| 7 | 9999 | light rain |
| 8 | 9999 | light rainshowers |
| 9 | 13.0 | heavy rain |
| 10 | 0 | |
| 11 | 8.0 | heavy rainshowers |
| 12 | 0 | |
| 13 | 9999 | light rainshowers |
| 14 | 0 | |
| 15 | 25.8 | heavy rain |
| 16 | 23.6 | heavy rain |
| 17 | 1.5 | light rain |
| 18 | 6.0 | heavy rainshowers |
| 19 | 2.0 | light rain |
| 20 | 26.0 | heavy rain |
| 21 | 7.6 | light rain |
| 22 | 0.5 | light rainshowers |
| 23 | 9999 | light rainshowers |
| 24 | 12.5 | heavy rain |
| 25 | 0 | |
| 26 | 0 | |
| 27 | 1.5 | light rainshowers |
| 28 | 0 | |
| 29 | 9.3 | moderate rain |
| 30 | 0 | |
| TOTAL | 156.3 | millimeters |

Note: 9999 an amount less than 0.1mm or negligible
Light = trace to 2.5 mm per hour; maximum of 0 .3 mm in 6 minutes
Moderate = 2.6 mm to 7.6 mm per hour, more than 0.3 but not greater than 0.8 in 6 mins
Heavy = more than 7.6 mm per hour; more than 0.8 mm in 6 minutes

Certified True Copy:

CECILIA P. DE OCAMPO
Officer – in – Charge
PAGASA Weather Station
Tayabas City

| AUGUST 2015 | Rainfall Amount (millimeters) | |
|---|---|---|
| 1 | 15.0 | heavy rain |
| 2 | 0 | |
| 3 | 9999 | light rainshowers |
| 4 | 0 | |
| 5 | 12.5 | heavy rain |
| 6 | 0.5 | light rain |
| 7 | 9999 | light rainshowers |
| 8 | 0 | |
| 9 | 4.0 | moderate rainshowers |
| 10 | 0 | |
| 11 | 25.3 | heavy rain |
| 12 | 4.0 | light rain |
| 13 | 1.0 | light rain |
| 14 | 1.0 | light rainshowers |
| 15 | 0 | |
| 16 | 9999 | light rainshowers |
| 17 | 9999 | light rainshowers |
| 18 | 4.0 | light rain |
| 19 | 0.5 | light rainshowers |
| 20 | 1.8 | light rainshowers |
| 21 | 54.5 | heavy rain |
| 22 | 21.0 | heavy rain |
| 23 | 0.5 | light rain |
| 24 | 0 | |
| 25 | 9999 | light rainshowers |
| 26 | 0 | |
| 27 | 0 | |
| 28 | 0 | |
| 29 | 17.1 | heavy rain |
| 30 | 0 | |
| 31 | 0 | |
| TOTAL | 162.7 | millimeters |

Note: 9999 an amount less than 0.1mm or negligible

Light = trace to 2.5 mm per hour; maximum of 0 .3 mm in 6 minutes

Moderate = 2.6 mm to 7.6 mm per hour, more than 0.3 but not greater than 0.8 in 6 mins

Heavy = more than 7.6 mm per hour; more than 0.8 mm in 6 minutes

Certified True Copy:

CECILIA P. DE OCAMPO
Officer – in – Charge
PAGASA Weather Station
Tayabas City

| OCTOBER 2015 | Rainfall Amount (millimeters) | |
|---|---|---|
| 1 | 30.0 | heavy rain |
| 2 | 9999 | light rain |
| 3 | 0.5 | light rain |
| 4 | 39.4 | heavy rain |
| 5 | 109.6 | heavy rain |
| 6 | 0 | |
| 7 | 0 | |
| 8 | 0.5 | light rainshowers |
| 9 | 0 | |
| 10 | 9999 | light rainshowers |
| 11 | 0 | |
| 12 | 31.1 | heavy rain |
| 13 | 17.0 | heavy rain |
| 14 | 1.0 | light rainshowers |
| 15 | 0 | |
| 16 | 7.5 | light rain |
| 17 | 6.0 | light rain |
| 18 | 15.5 | heavy rain |
| 19 | 7.0 | light rain |
| 20 | 0 | |
| 21 | 0 | |
| 22 | 0 | |
| 23 | 0 | |
| 24 | 0 | |
| 25 | 0 | |
| 26 | 9999 | light rainshowers |
| 27 | 2.0 | light rainshowers |
| 28 | 0.5 | light rainshowers |
| 29 | 9999 | light rainshowers |
| 30 | 1.0 | light rainshowers |
| 31 | 66.0 | heavy rain |
| TOTAL | 334.6 | millimeter |

Note: 9999 an amount less than 0.1mm or negligible
Light = trace to 2.5 mm per hour; maximum of 0 .3 mm in 6 minutes
Moderate = 2.6 mm to 7.6 mm per hour, more than 0.3 but not greater than 0.8 in 6 mins
Heavy = more than 7.6 mm per hour; more than 0.8 mm in 6 minutes

Certified True Copy:

CECILIA P. DE OCAMPO
Officer – in – Charge
PAGASA Weather Station
Tayabas City

| December 2015 | Rainfall Amount ( millimeters ) | |
|---|---|---|
| 1 | 7.0 | light rain |
| 2 | 9999 | light rainshowers |
| 3 | 2.0 | light rainshowers |
| 4 | 9.2 | light rain |
| 5 | 1.0 | light rainshowers |
| 6 | 0 | |
| 7 | 19.8 | moderate rain |
| 8 | 6.0 | light rain |
| 9 | 0.5 | light rainshowers |
| 10 | 0 | |
| 11 | 4.0 | light rain |
| 12 | 2.0 | light rainshowers |
| 13 | 0.5 | light rainshowers |
| 14 | 49.8 | moderate rain |
| 15 | 89.8 | heavy rain |
| 16 | 20.0 | heavy rain |
| 17 | 27.0 | heavy rain |
| 18 | 140.0 | heavy rain |
| 19 | 107.3 | heavy rain |
| 20 | 0.5 | light rainshowers |
| 21 | 1.0 | light rainshowers |
| 22 | 3.9 | ligth rain |
| 23 | 9999 | light rainshowers |
| 24 | 0 | |
| 25 | 9999 | light rain |
| 26 | 17.1 | moderate rain |
| 27 | 0 | |
| 28 | 9999 | light rainshowers |
| 29 | 9999 | light rainshowers |
| 30 | 10.4 | moderate rain |
| 31 | 25.8 | heavy rain |
| TOTAL | 544.6 | millimeters |

Note: 9999 an amount less than 0.1mm or negligible
Light = trace to 2.5 mm per hour; maximum of 0 .3 mm in 6 minutes
Moderate = 2.6 mm to 7.6 mm per hour, more than 0.3 but not greater than 0.8 in 6 mins
Heavy = more than 7.6 mm per hour; more than 0.8 mm in 6 minutes

Certified True Copy:

CECILIA P. DE OCAMPO
Officer – in – Charge
PAGASA Weather Station
Tayabas City

# Appendix H
# Analysis of Variance

Table 9. Analysis of Variance of Four sampling period per stations.

**JUNE**

| Properties | Sum of Squares | | Mean Squares | | Df | | F-Ratio | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Between | Within | Between | Within | Bet. | Wit. | Com | Tab | |
| Chloride | 0.667 | 0.000 | 0.333 | 0.000 | 2 | 0 | 0.000 | | |
| Phosphate | 0.000 | 0.000 | 0.000 | 0.000 | 2 | 0 | 0.000 | | |
| Nitrate | 0.005 | 0.000 | 0.002 | 0.000 | 2 | 6 | 41.808 | 10.92 | Significant |
| Sulfate | 3.282 | 0.753 | 1.641 | 0.126 | 2 | 6 | 13.071 | 10.92 | Significant |
| Dissolved Oxygen | 0.207 | 0.000 | 0.103 | 0.000 | 2 | 0 | 0.000 | | |
| Total Dissolved Solids | 144.667 | 0.000 | 72.333 | 0.000 | 2 | 0 | 0.000 | | |
| Total Suspended Solids | 2.667 | 0.000 | 1.333 | 0.000 | 2 | 0 | 0.000 | | |

**AUGUST**

| Properties | Sum of Squares | | Mean Squares | | Df | | F-Ratio | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Between | Within | Between | Within | Bet. | Wit. | Com | Tab | |
| Chloride | 57.110 | 18.193 | 28.555 | 3.032 | 2 | 6 | 9.418 | 10.92 | Not Significant |
| Phosphate | 0.001 | 0.002 | 0.001 | 0.000 | 2 | 6 | 1.805 | 10.92 | Not Significant |
| Nitrate | 0.002 | 0.000 | 0.001 | 0.000 | 2 | 6 | 13.405 | 10.92 | Significant |
| Sulfate | 38.311 | 0.269 | 19.156 | 0.045 | 2 | 6 | 426.838 | 10.92 | Significant |
| Dissolved Oxygen | 0.069 | 1.427 | 0.034 | 0.238 | 2 | 6 | 0.145 | 10.92 | Not Significant |
| Total Dissolved Solids | 530.667 | 57.333 | 265.333 | 9.556 | 2 | 6 | 27.767 | 10.92 | Significant |
| Total Suspended Solids | 11.556 | 0.667 | 5.778 | 0.111 | 2 | 6 | 52.000 | 10.92 | Significant |

**OCTOBER**

| Properties | Sum of Squares | | Mean Squares | | Df | | F-Ratio | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Between | Within | Between | Within | Bet. | Wit. | Com | Tab | |
| Chloride | 0.436 | 6.275 | 0.218 | 1.046 | 2 | 6 | 0.208 | 10.92 | Not Significant |
| Phosphate | 0.001 | 0.016 | 0.000 | 0.003 | 2 | 6 | 0.142 | 10.92 | Not Significant |
| Nitrate | 0.034 | 0.001 | 0.017 | 0.000 | 2 | 6 | 155.018 | 10.92 | Significant |
| Sulfate | 74.393 | 0.229 | 37.196 | 0.038 | 2 | 6 | 974.012 | 10.92 | Significant |
| Dissolved Oxygen | 1.007 | 0.033 | 0.503 | 0.006 | 2 | 6 | 90.600 | 10.92 | Significant |
| Total Dissolved Solids | 155.556 | 916.667 | 77.778 | 152.778 | 2 | 6 | 0.509 | 10.92 | Not Significant |
| Total Suspended Solids | 48.222 | 34.667 | 24.111 | 5.778 | 2 | 6 | 4.173 | 10.92 | Not Significant |

**DECEMBER**

| Properties | Sum of Squares | | Mean Squares | | Df | | F-Ratio | | Remarks |
|---|---|---|---|---|---|---|---|---|---|
| | Between | Within | Between | Within | Bet. | Wit. | Com | Tab | |
| Chloride | 53.022 | 6.165 | 26.511 | 1.028 | 2 | 6 | 25.800 | 10.92 | Significant |
| Phosphate | 0.034 | 0.000 | 0.017 | 0.000 | 2 | 6 | 1018.941 | 10.92 | Significant |
| Nitrate | 0.662 | 0.002 | 0.331 | 0.000 | 2 | 6 | 851.579 | 10.92 | Significant |
| Sulfate | 238.862 | 0.390 | 119.431 | 0.065 | 2 | 6 | 1837.712 | 10.92 | Significant |
| Dissolved Oxygen | 0.007 | 0.073 | 0.003 | 0.012 | 2 | 6 | 0.273 | 10.92 | Not Significant |
| Total Dissolved Solids | 4050.000 | 950.000 | 2025.000 | 158.333 | 2 | 6 | 12.789 | 10.920 | Significant |
| Total Suspended Solids | 128 | 26 | 64 | 4.333 | 2 | 6 | 14.769 | 10.92 | Significant |

Table 10. Analysis of Variance of three station per sampling period.

| Station 1 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Properties | Sum of Squares | | Mean Squares | | F-Ratio | | Remarks |
| | Between | Within | Between | Within | Com | Tab | |
| Chloride | 36.04987 | -916.818 | 12.01662 | -152.803 | 0.0786 | 8.02 | Not Significant |
| Phosphate | 419.7274 | -16446.3 | 139.9091 | -2055.78 | 0.0681 | 8.02 | Not Significant |
| Nitrate | 0.059766 | -0.88205 | 0.019922 | -0.11026 | 0.1807 | 8.02 | Not Significant |
| Sulfate | 419.7274 | -16446.3 | 139.9091 | -2055.78 | 0.0681 | 8.02 | Not Significant |
| Dissolved Oxygen | 21.016 | -2342.5 | 7.005333 | -292.812 | 0.0239 | 8.02 | Not Significant |
| Total Dissolved Solids | 12770.92 | -311292 | 4256.972 | -38911.5 | 0.1094 | 8.02 | Not Significant |
| Total Suspended Solids | 73.6 | -766.933 | 24.53333 | -95.8667 | 0.2559 | 8.02 | Not Significant |

| Station 2 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Properties | Sum of Squares | | Mean Squares | | F-Ratio | | Remarks |
| | Between | Within | Between | Within | Com | Tab | |
| Chloride | 141.7064 | -1063.29 | 47.23547 | -177.215 | 0.2665 | 8.02 | Not Significant |
| Phosphate | 676.5462 | -17573.9 | 225.5154 | -2196.74 | 0.1027 | 8.02 | Not Significant |
| Nitrate | 0.596165 | -3.01691 | 0.198722 | -0.37711 | 0.527 | 8.02 | Not Significant |
| Sulfate | 676.5462 | -17573.9 | 225.5154 | -2196.74 | 0.1027 | 8.02 | Not Significant |
| Dissolved Oxygen | 19.17833 | -2498.46 | 6.392778 | -312.307 | 0.0205 | 8.02 | Not Significant |
| Total Dissolved Solids | 23198.92 | -378404 | 7732.972 | -47300.5 | 0.1635 | 8.02 | Not Significant |
| Total Suspended Solids | 240.9333 | -2700.93 | 80.31111 | -337.617 | 0.2379 | 8.02 | Not Significant |

| Station 3 | | | | | | | |
|---|---|---|---|---|---|---|---|
| Properties | Sum of Squares | | Mean Squares | | F-Ratio | | Remarks |
| | Between | Within | Between | Within | Com | Tab | |
| Chloride | 248.199 | -990.763 | 82.73301 | -165.127 | 0.501 | 8.02 | Not Significant |
| Phosphate | 2610.987 | -10511.8 | 870.3289 | -1313.98 | 0.6624 | 8.02 | Not Significant |
| Nitrate | 0.007637 | -0.95035 | 0.002546 | -0.11879 | 0.0214 | 8.02 | Not Significant |
| Sulfate | 1211.036 | -23315.6 | 403.6785 | -2914.44 | 0.1385 | 8.02 | Not Significant |
| Dissolved Oxygen | 244.2293 | -954.073 | 81.40978 | -119.259 | 0.6826 | 8.02 | Not Significant |
| Total Dissolved Solids | 20766.92 | -402886 | 6922.306 | -50360.8 | 0.1375 | 8.02 | Not Significant |
| Total Suspended Solids | 327.4333 | -2172.77 | 109.1444 | -271.596 | 0.4019 | 8.02 | Not Significant |

# Appendix I
# Gantt Chart

# Appendix J
# Itemized Budget

# Line Item Budget

Title of the Study: **Water Quality and Macro-invertebrates Diversity of Talon Falls at Tayabas Quezon**

Proponents: **Eljohn Dave P. Camposano, Alessandro R. Galang and Edzel V. Pares**

| | | |
|---|---|---|
| **I. Materials and Supplies** | | |
| Plastic Containers | | 300.00 |
| Amber Bottles | | 180.00 |
| Vials | | 120.00 |
| Nets | | 150.00 |
| Secchi Disk | | 480.00 |
| Filter Papers | | 780.00 |
| | **Total** | **2,010.00** |
| **II. Laboratory Expenses** | | |
| Testing of Water Samples | | 54,000.00 |
| Authentication of Specimens | | 1,700.00 |
| | **Total** | **55,700.00** |
| **III. Transportation** | | |
| Manila – Brgy. Illayang Bukal | | 280 |
| Brgy. Illayang Bukal - Manila | | 250 |
| Manila – Las Piñas | | 40 |
| Manila - Binakayan | | 50 |
| | **Total** | **4,240.00** |
| **IV. Food** | | **2,500.00** |
| **V. Manuscript** | | **2430.00** |
| **VI. Other Expenditures** | | **1,500.00** |
| | **Overall Total** | **68,380.00** |

# Appendix K
# Letters

**Technological University of the Philippines**
**Ayala Blvd., Ermita, Manila**
**College of Science**
**Department of Chemistry**

June 13, 2015

Veronica Francia Laguartilla
Chairman
Barangay Ilayang Bukal,
Tayabas, Quezon

Madam:

Greetings of Peace!

Our university offers Bachelor of Science in Environmental Science (BSES), as part of this curriculum; students are required to do a research study relevant to the course. In line with this, we, students from Technological university of the Philippines – Manila will conduct a study entitled "Water Quality Assessment and Macro-Invertebrate Diversity at Talon Falls ~~and Dumuit Stream~~ in Tayabas, Quezon" for the months of June 2015 to January 2016.

This study will serve as baseline information of Talon Falls ~~and Dumuit Stream~~ to the future researchers embarking on the study of water quality including physico-chemical parameters and diversity of macro-invertebrates in the area.

As part of the study, we will be taking water samples and macro-invertebrates in the said location and we will be gather information regarding the study. Rest assured that the results of the study will be also forwarded to your good office.

Thank you very much in participation of your favorable condition.

Respectfully yours,

Camposano, Eljohn Dave D.

Galang, Alessandro R.

Pares, Edzel V.

Noted by:

Corazon D. Sacdalan
Thesis Adviser

Fidela Q. Arañes
Head, Department of Chemistry

Veronica Francia Laguartilla
Brgy. Ilayang Bukal, Tayabas, Quezon
chairman

**Technological University of the Philippines**
**Ayala Blvd., Ermita, Manila**
**College of Science**
**Department of Chemistry**

June 15, 2015

HON. FAUSTINO A. SILANG, DMD
City Mayor, Tayabas City

THRU: Veronica F. Laguartilla
Brgy. Captain
Brgy. Ilayang Bukal, Tayabas, Quezon

6.15.15

OFFICE OF THE MAYOR
RECEIVED
BY: 2 PM
DATE JUN 15 2015

Dear Sir:

Greetings of Peace!

We, Eljohn Dave P. Camposano, Alessandro R. Galang, Edzel V. Pares are senior Bachelor of Science in Environmental Science students of Technological University of the Philippines-Manila. As partial fulfillment of our course, we are currently working with our thesis entitled "Water Quality Assessment and Macro-Invertebrates Diversity at Talon Falls ~~and Dumuit Stream~~ in Tayabas, Quezon for the months of June 2015 to December 2015.

This study will serve as baseline information of Talon Falls ~~and Dumuit Stream~~ to the future researchers embarking on the study of water quality including physico-chemical parameters and diversity of macro-invertebrates in the area.

As part of the study, we will be taking water samples and macro-invertebrates in the said location and we will gather information regarding the study. Rest assured that the results of the study will be also forwarded to your good office and the natural habitat of macro-invertebrates will not be affected.

Thank you very much in participation of your favorable condition.

Respectfully yours,

Camposano, Eljohn Dave P.
09283862117

Galang, Alessandro R.
09154013524

Pares, Edzel V.
09094246948

noted:

EDNA E. ECLAVEA, RL, MAEd
City Administrator

**Technological University of the Philippines**
Ayala Blvd., Ermita, Manila
College of Science
Department of Chemistry

August 06, 2015

Atty. Asis G. Perez
Director
Bureau of Fisheries and Aquatic Resources
3rd Flr. PCA Bldg., Elliptical Road, Diliman, Quezon City

Dear Mr. Perez:

The undersigned is a full time faculty of the College of Science, Chemistry Department of the Technological University of the Philippines-Manila and Thesis adviser of the group who wishes to collect specimens of macroinvertebrates from Brgy. Ilayang Bukal, Tayabas, Quezon. The Group will be conducting a research study entitled "*Water Quality and Macro-invertebrates Diversity of Talon Falls in Tayabas Quezon*". The objective of their research is to determine the diversity of macroinvertebrates of Talon Falls in Tayabas, Quezon.

In line with this, may I ask permission from your good office to allow the group to collect specimens needed for their study from the month of August, October, and December.

Hoping for your kind consideration, Thank you very much.

Respectfully yours,

Corazon D. Sacdalan
Thesis Adviser
Faculty, Chemistry Department

Noted by,

Teresa M. Ranay
Head, Chemistry Department

Fidela Q. Arañes
OIC-Dean, College of Science

**Technological University of the Philippines**
Ayala Blvd., Ermita, Manila
College of Science
Department of Chemistry

August 06, 2015

**ATTY. ASIS G. PEREZ**
Director
Bureau of Fisheries and Aquatic Resources
3rd Flr. PCA Bldg., Elliptical Road, Diliman, Quezon City

Dear Mister Perez:

The undersigned students are taking up Bachelor of Science in Environmental Science is conducting a research study entitled **"Water Quality and Macro-Invertebrates Diversity of Talon Falls in Tayabas Quezon"**. The group will collect species for the identification and determination of the diversity of the said area on August 17, 2015.

In line with this, may we request from your good office to allow us to collect macroinvertebrates for our research.

Hoping for your kind consideration

Respectfully yours,

Eljohn Dave P. Camposano
Student / Researcher

Edzel V. Pares
Student / Researcher

Alessandro R. Galang
Student / Researcher

Noted By:

Corazon D. Sacdalan
Thesis Adviser

Teresa M. Ranay
Head, Chemistry Department

Fidela Q. Arañes
OIC-Dean, College of Science

# Appendix L
# Gratuitous Permit

Republic of the Philippines
DEPARTMENT OF AGRICULTURE
Elliptical Road, Diliman, Quezon City, 1100
Telephone Nos. (02) 927-8741 to 56

**GRATUITOUS PERMIT**
**No.** 0103-15

**Gratuitous Permit for the Undergraduate Students of Technological University of the Philippines to collect freshwater specimens for scientific research**

Pursuant to Sections 2, 5, 11, 86, 91 and other relevant provisions of Republic Act No. 8550, otherwise known as "The Fisheries Code of 1998", and the provisions of Republic Act No. 9147 otherwise known as, "The Wildlife Resources Conservation and Protection Act", particularly Section 15, and its Implementing Rules and Regulations (IRR), this Gratuitous Permit (GP) is hereby granted to **ALESSANDRO R. GALANG, EDZEL V. PARES ,** and **ELJOHN DAVE P. CAMPOSANO**, for the collection of freshwater maroinvertebrates including their symbionts using non-destructive methods within the selected collection site in Talon Falls in Tayaban, Quezon Province in the conduct of scientific study entitled, *"Water Quality and Macroinvertebrates Diversity of Talon Falls in Tayabas, Quezon"*, subject to the following terms and conditions:

1. Collection shall be undertaken only in identified areas with Prior Informed Consent from the Local Government Units (LGU), Protected Area Management Board (PAMB), and other related agencies or institutions concerned where the collection shall be made;
2. Collection of live specimens shall be through methods that will not inflict, harm or damage the species and minimize adverse impacts on the ecosystem of the collection site;
3. The permittees shall execute an Affidavit of Undertaking in the form provided;
4. The permittees shall submit to DA-BFAR, through the Fisheries Quarantine and Wildlife Regulations Section (FQWRS) of Fisheries Regulatory and Quarantine Division, a complete set of well-preserved and properly labeled voucher specimens collected from the study sites within thirty (30) days from last collection;
5. The permittees shall submit to DA-BFAR, through the Fisheries Quarantine and Wildlife Regulations Section, a terminal report incorporating an inventory of all collected specimens related to the study with representative photo documentation of the collection methods employed, if any, upon completion of the research as stipulated in the Memorandum of Agreement;
6. The permittees shall furnish the DA-BFAR, a copy of the research report and educational materials developed and covered by this GP;
7. This Permit shall be valid for one (1) year upon approval hereof, and shall be surrendered to DA-BFAR upon expiration of the term herein provided; and,
8. Any violation of the aforementioned laws and applicable rules and regulations, Memorandum of Agreement, as well as the terms and conditions stipulated herein, shall result in the automatic revocation of this Gratuitous Permit.

Issued this 14th day of October, 2015 in Quezon City, Philippines.

**PROCESO J. ALCALA**
Secretary, DA

DEPARTMENT OF AGRICULTURE
in replying pls cite this code
For Signature: S-10-15-0177
Received : 10/12/2015 08:48 AM

# Appendix M
# Certificate of Results

Republic of the Philippines
Department of Environment and Natural Resources
**ENVIRONMENTAL MANAGEMENT BUREAU**
**Regional Office IV-CALABARZON**
*6/F DENR by the Bay, 1515 L&S Bldg. Roxas Blvd., Ermita, Manila*
*Tel. No. 536-9784 / 525-0348*

## RESULTS OF PHYSICAL AND CHEMICAL ANALYSIS



SOURCE : **TALON FALLS**
ADDRESS : Tayabas, Quezon
SAMPLED BY : Eljohn Dave Camposano, Alessandro R. Galang & Edzel V. Pares
DATE SAMPLED : 16 June 2015 DATE ANALYZED : 16 June 2015
DATE RECEIVED : 16 June 2015 DATE REPORTED : 01 July 2015

| Laboratory Sample No. | Station Number | Time of Collection | Station Identification |
|---|---|---|---|
| 15 – 0458 | 1 | 09:00 AM | Station 1 |
| 15 – 0459 | 2 | 09:00 AM | Station 2 |
| 15 – 0460 | 3 | 09:00 AM | Station 3 |

| CHARACTERISTIC | STATION NUMBERS | | | | |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | ~ | |
| Ammonia, mg/L | < 0.001 | < 0.001 | < 0.001 | | |
| Chlorides, mg/L | 2 | 3 | 3 | | |
| Dissolved Oxygen, mg/L | 9.20 | 9.80 | 9.30 | | |
| Phosphate, mg/L | 0.097 | 0.070 | 0.086 | | |
| Total Dissolved Solids, mg/L | 116 | 103 | 119 | | |
| Total Suspended Solids, mg/L | 3 | 5 | 3 | | |

REMARKS: Samples analyzed as received.
Methods of analysis are based on Standard Methods for the Examination of Water and Wastewater, 21st Edition.
Result are average of three ~~sampl~~ triak.

*ANALYZED BY:*

**CLARISSA M. BUSTARDE**
Laboratory Analyst

**ARLYN R. LOPEZ**
Laboratory Analyst

**KATHLEEN CHRISTINE E. AQUINO**
Laboratory Chemist

**ANDY B. AQUINO**
Laboratory Chemist

*APPROVED BY:*

**MARISSA DC. MALABANA**
OIC, Laboratory Services Section

*NOTED BY:*

**JESSIE A. CONDE**
Chief, Pollution Control Division

*NOTED BY:*

**ENGR. CARLOS J. MAGNO**
Regional Director

Republic of the Philippines
Department of Environment and Natural Resources
**ENVIRONMENTAL MANAGEMENT BUREAU**
**Regional Office IV-CALABARZON**
*6/F DENR by the Bay, 1515 L&S Bldg. Roxas Blvd., Ermita, Manila*
*Tel. No. 536-9784 / 525-0348*

## RESULTS OF BACTERIOLOGICAL ANALYSIS



SOURCE : **TALON FALLS**
ADDRESS : Tayabas, Quezon
SAMPLED BY : Eljohn Dave Camposano, Alessandro R. Galang & Edzel V. Pares
DATE SAMPLED : 16 June 2015 DATE ANALYZED : 16 June 2015
DATE RECEIVED : 16 June 2015 DATE REPORTED : 01 July 2015

| Laboratory Sample No. | Station Identification | Total Coliform, MPN/100 mL | Fecal Coliform, MPN/100 mL |
|---|---|---|---|
| 15 – 0458 | Station 1 | $13 \times 10^2$ | 30 |
| 15 – 0459 | Station 2 | $40 \times 10^2$ | 700 |
| 15 – 0460 | Station 3 | $60 \times 10^2$ | $50 \times 10^2$ |

REMARKS: Samples analyzed as received.
Methods of analysis are based on Standard Methods for the Examination of Water and Wastewater, 21st Edition.
Results are average of three trials.

*ANALYZED BY:*

**CLARISSA M. BUSTARDE**
Laboratory Analyst

**ARLYN R. LOPEZ**
Laboratory Analyst

**KATHLEEN CHRISTINE E. AQUINO**
Laboratory Chemist

**ANDY B. AQUINO**
Laboratory Chemist

*APPROVED BY:*

**MARISSA DC. MALABANA**
OIC, Laboratory Services Section

*NOTED BY:*

**JESSIE A. CONDE**
Chief, Pollution Control Division

*NOTED BY:*

**ENGR. CARLOS J. MAGNO**
Regional Director

**MACH UNION LABORATORY**

duly registered under

**MACH UNION WATER LABORATORY, INC.**
Mach Union Building., 335 Real Street, (formerly Alabang-Zapote Rd.),
Talon 3, 1740 Las Piñas City, Philippines
Tel. No.: 553-8381 / 553-8382 / 553-8879 Fax No.: 553-8878
Email: info@machunion.com• Website: www.machunion.com

Recognized: Department of Health (DOH) • Department of Environment & Natural Resources(DENR)

PAB ACCREDITED
TESTING LABORATORY
PNS ISO/IEC 17025:2005
LA-2012-215A / LA-2012-216A

# Report of Special Analysis

**Job Number** : **0000068280** **Laboratory Number** : **SP15-02041** **Date:** 08/12/2015

**Customer** : **NCRMNL-000334 E.PARES/ A.GALANG/E.CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA

**Sampling Date** : 08/03/2015 **Date Received :** 08/04/2015 **Date Analyzed :** 08/04/2015
**Sample Type** : WATER
**Sample Description** : SITE 1 / TRIAL 1
**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES/ A. GALANG/ E. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.258 |
| Sulfate | Turbidimetric | mg/L | 12.6 |

ORIGINAL COPY

*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

** Customer/s is/are given seven (7) days upon receipt of report to question any discrepancies (i.e. customer name & address, sample description, results, etc.)

Analyzed by:

**SEAN MIGUEL B. ROMERO**
Laboratory Analyst

Certified by:

**MARISA T. MANAOR**
Chemist, PRC No. 5465
for Physical & Chemical Analysis

Noted by:

**ALADINO M. ABULENCIA**
Technical Manager

**MACH UNION LABORATORY**
duly registered under
**MACH UNION WATER LABORATORY, INC.**
Mach Union Building., 335 Real Street, (formerly Alabang-Zapote Rd.),
Talon 3, 1740 Las Piñas City, Philippines
Tel. No.: 553-8381 / 553-8382 / 553-8879 Fax No.: 553-8878
Email: info@machunion.com● Website: www.machunion.com
Recognized: Department of Health (DOH) ● Department of Environment & Natural Resources(DENR)

PAB ACCREDITED
TESTING LABORATORY
PNS ISO/IEC 17025:2005
LA-2012-215A / LA-2012-216A

# Report of Special Analysis

**Job Number** : **0000068283** **Laboratory Number** : **SP15-02044** **Date:** 08/12/2015

**Customer** : **NCRMNL-000334 E.PARES/ A.GALANG/E.CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA

**Sampling Date** : 08/03/2015 **Date Received :** 08/04/2015 **Date Analyzed :** 08/04/2015
**Sample Type** : WATER
**Sample Description** : SITE 2 / TRIAL 1
**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES/ A. GALANG/ E. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.233 |
| Sulfate | Turbidimetric | mg/L | 11.1 |

ORIGINAL COPY

*Reference:* STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012

** Customer/s is/are given seven (7) days upon receipt of report to question any discrepancies (i.e. customer name & address, sample description, results, etc.)

Analyzed by:
SEAN MIGUEL B. ROMERO
Laboratory Analyst

Certified by:
MARISA T. MANAOR
Chemist, PRC No. 5465
for Physical & Chemical Analysis

Noted by:
ALADINO M. ABULENCIA
Technical Manager

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Recognized: Department of Health (DOH) • Department of Environment & Natural Resources(DENR)

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PNS ISO/IEC 17025:2005
LA-2012-215A / LA-2012-216A

# Report of Special Analysis

**Job Number** : **0000068286** **Laboratory Number** : **SP15-02047** **Date:** 08/12/2015

**Customer** : **NCRMNL-000334** **E.PARES/ A.GALANG/E.CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES - MANILA

**Sampling Date** : 08/03/2015 **Date Received :** 08/04/2015 **Date Analyzed :** 08/04/2015
**Sample Type** : WATER
**Sample Description** : SITE 3 / TRIAL 1
**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES/ A. GALANG/ E. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.207 |
| Sulfate | Turbidimetric | mg/L | 13.0 |

ORIGINAL COPY

*Reference:* STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012

** Customer/s is/are given seven (7) days upon receipt of report to question any discrepancies (i.e. customer name & address, sample description, results, etc.)

Analyzed by:
**SEAN MIGUEL B. ROMERO**
Laboratory Analyst

Certified by:
**MARISA T. MANAOR**
Chemist, PRC No. 5465
for Physical & Chemical Analysis

Noted by:
**ALADINO M. ABULENCIA**
Technical Manager

**MACH UNION LABORATORY**

duly registered under

**MACH UNION WATER LABORATORY, INC.**
Mach Union Building., 335 Real Street, (formerly Alabang-Zapote Rd.),
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Recognized: Department of Health (DOH) • Department of Environment & Natural Resources(DENR)

PAO ACCREDITED
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PNS ISO/IEC 17025:2005
LA-2012-215A
LA-2012-216A

# Report of Special Analysis

**Job Number** : **0000070239** **Laboratory Number** : **SP15-02231** **Date:** 08/29/2015

**Customer** : **NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 08/18/2015 **Date Received :** 08/19/2015 **Date Analyzed :** 08/19/2015

**Sample Type** : WATER

**Sample Description** : TALON FALLS - STATION 1 TRIAL 1

**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES, A. GALANG, E.D. CAMPOSANO**

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| Parameters | Method | Unit | Result | |
|---|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.257 | * |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.076 | * |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 79 x $10^2$ | |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 2.0 x $10^2$ | |

ORIGINAL COPY

*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

* Test results which are outside the laboratory's scope of accreditation for ISO/IEC 17025:2005.

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Accredited Signatory:
**RHODORA B.S. TILO**
Laboratory Analyst

Certified by:
**MARISA T. MANAOR**
Chemist, PRC No. 5465
for Physical & Chemical Analysis

**ZORAIDA T. FRANCISCO**
Microbiologist, RMT PRC No. 10574
for Microbiological Analysis

Noted by:
**ALADINO M. ABULENCIA**
Technical Manager

**MACH UNION LABORATORY**
duly registered under
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# Report of Special Analysis

**Job Number** : **0000070242** **Laboratory Number** : **SP15-02234** **Date:** 08/29/2015

**Customer** : **NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 08/18/2015 **Date Received :** 08/19/2015 **Date Analyzed :** 08/19/2015
**Sample Type** : WATER
**Sample Description** : TALON FALLS - STATION 2 TRIAL 1
**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result | |
|---|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.245 | * |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.061 | * |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 24 x $10^2$ | |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 230 | |

ORIGINAL COPY

*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

* Test results which are outside the laboratory's scope of accreditation for ISO/IEC 17025:2005.

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Accredited Signatory:
**RHODORA B.S. TILO**
Laboratory Analyst

Certified by:
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for Physical & Chemical Analysis

**ZORAIDA T. FRANCISCO**
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LA-2012-216A

# Report of Special Analysis

**Job Number** : **0000070245** **Laboratory Number** : **SP15-02237** **Date:** 08/29/2015

**Customer** : **NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 08/18/2015 **Date Received :** 08/19/2015 **Date Analyzed :** 08/19/2015
**Sample Type** : WATER
**Sample Description** : TALON FALLS - STATION 3 TRIAL 1
**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result | |
|---|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.216 | * |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.050 | * |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 49 x 10 ² | |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 49 x 10 ² | |

ORIGINAL COPY

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* Test results which are outside the laboratory's scope of accreditation for ISO/IEC 17025:2005.

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Accredited Signatory:
**RHODORA B.S. TILO**
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Certified by:
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Chemist, PRC No. 5465
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# Report of Special Analysis

**Job Number** : **0000078063** **Laboratory Number** : **SP15-02924** **Date:** 11/05/2015

**Customer** : **NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 10/17/2015 **Date Received :** 10/21/2015 **Date Analyzed :** 10/21/2015

**Sample Type** : WATER

**Sample Description** : TALON FALLS - STATION 1 TRIAL 1

**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.339 |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.065 |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 21 x 10 ² |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 21 x 10 ² |

ORIGINAL COPY

*Reference:* *STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

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Analyzed by:
**RHODORA B.S. TILO**
Laboratory Analyst

Certified by:
**MARISA T. MANAOR**
Chemist, PRC No. 5465
for Physical & Chemical Analysis

**ZORAIDA T. FRANCISCO**
Microbiologist, RMT PRC No. 10574
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## Report of Special Analysis

**Job Number** : **0000078545** **Laboratory Number** : **SP15-02927** **Date:** 11/05/2015

**Customer** : **NCRMNL-000334** **E. PARES, A. GALANG, E.D. CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 10/17/2015 **Date Received :** 10/21/2015 **Date Analyzed :** 10/21/2015

**Sample Type** : WATER

**Sample Description** : TALON FALLS - STATION 2 TRIAL 1

**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.214 |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.181 |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 140 |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 23 |

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*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

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Analyzed by:
**RHODORA B.S. TILO**
Laboratory Analyst

Certified by:
**MARISA T. MANAOR**
Chemist, PRC No. 5465
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## Report of Special Analysis

**Job Number** : **0000078552** **Laboratory Number** : **SP15-02930** **Date:** 11/05/2015

**Customer** : **NCRMNL-000334** **E. PARES, A. GALANG, E.D. CAMPOSANO**

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 10/17/2015 **Date Received :** 10/21/2015 **Date Analyzed :** 10/21/2015

**Sample Type** : WATER

**Sample Description** : TALON FALLS - STATION 3 TRIAL 1

**Remarks** :

Analysis are based on sample (s) submitted by: **E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.220 |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.053 |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 14 x 10 ² |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 170 |

ORIGINAL COPY

*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

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Analyzed by:
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Certified by:
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## REPORT OF ANALYSIS

**Job Number** : 0000085854 **Laboratory Number** : SP15-003657 **Date:** 01/08/2016

**Customer** : NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 12/16/2015 **Date Received** : 12/17/2015 **Date Analyzed** : 12/17/2015

**Sample Type** : WATER

**Sample Description** : STATION 1 (TALON FALLS 1) - T1

**Remarks** : -

Analysis are based on sample (s) submitted by: **NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.175 |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.145 |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 220 |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | 170 |

ORIGINAL COPY

*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

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Analyzed by:

SEAN MIGUEL B. ROMERO / L.A. BELLOSILLO
Laboratory Analysts

Certified by:

MARISA T. MANAOR
Chemist, PRC No. 5465
for Physical & Chemical Analysis

ZORAIDA T. FRANCISCO
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Noted by:

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## REPORT OF ANALYSIS

**Job Number** : 0000085880 **Laboratory Number** : SP15-003660 **Date:** 01/08/2016

**Customer** : NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 12/16/2015 **Date Received** : 12/17/2015 **Date Analyzed** : 12/17/2015

**Sample Type** : WATER

**Sample Description** : STATION 2 (TALON FALLS 2) - T1

**Remarks** : -

Analysis are based on sample (s) submitted by: **NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.737 |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.021 |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | $11 \times 10^4$ |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | < 1.8 |

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*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

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Analyzed by:

SEAN MIGUEL B. ROMERO / L.A. BELLOSILLO
Laboratory Analysts

Certified by:

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ZORAIDA T. FRANCISCO
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# REPORT OF ANALYSIS

**Job Number** : 0000085886 **Laboratory Number** : SP15-003663 **Date:** 01/08/2016

**Customer** : NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO

**Address** : TECHNOLOGICAL UNIVERSITY OF THE PHILIPPINES, AYALA BLVD., ERMITA, MANILA

**Sampling Date** : 12/16/2015 **Date Received** : 12/17/2015 **Date Analyzed** : 12/17/2015

**Sample Type** : WATER

**Sample Description** : STATION 3 (TALON FALLS 3) - T1

**Remarks** : -

Analysis are based on sample (s) submitted by: **NCRMNL-000334 E. PARES, A. GALANG, E.D. CAMPOSANO**

**Mach Union Water Laboratory, Inc. does not guarantee that sample(s) submitted is (are) representative of the whole bulk from where it/they was (were) taken. Reproduction of this report is not authorized except in full, without written approval of the laboratory.**

| Parameters | Method | Unit | Result |
|---|---|---|---|
| Nitrate | 4500-D. Ion Selective | mg/L | 0.161 |
| Phosphate | 4500-P D. Stannous Chloride | mg/L | 0.020 |
| Total Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | $17 \times 10^3$ |
| Fecal Coliform | 9221-E Multiple Tube Fermentation | MPN/100 ml | $11 \times 10^3$ |

ORIGINAL COPY

*Reference: STANDARD METHODS for Examination of Water and Wastewater, 22nd Edition, APHA, AWWA, WEF, Washington D.C. 2012*

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Analyzed by:
**SEAN MIGUEL B. ROMERO / L.A. BELLOSILLO**
Laboratory Analysts

Certified by:
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**ZORAIDA T. FRANCISCO**
Microbiologist, RMT PRC No. 10574
for Microbiological Analysis

Noted by:
**ALADINO M. ABULENCIA**
Technical Manager

# Appendix N
# Certificate of Authentication

NATIONAL MUSEUM
PAMBANSANG MUSEO

# CERTIFICATION

Date: January 29, 2016

This is to certify that the crab and shrimp specimens brought to the undersigned for identification by Edzel V. Pares, Alessandro R. Galang, Eljohn Dave P. Camposano of Technological University of the Philippines-Manila were identified as follows :

| Client Field Number | Family | Scientific Name | | Number of Individuals |
|---|---|---|---|---|
| | | *Genus* | *Species* | |
| | Parathelphusidae | *Sundathelphusa* | *sp.* | 1 |
| | Atyidae | *Caridina* | *sp.* | 4 |
| **TOTAL** | | | | 5 |

SPECIMEN DATA:

This certification is issued upon the request of the above students for whatever purpose this may serve.

**MARIVENE MANUEL-SANTOS**
Curator I, Zoology Division
Curator-In-Charge of Crustacea

Control Number 2016-003-CRUS
Official Receipt No. 9057880

ZOOLOGY DIVISION Tel No. : 63-2-4003239

NATIONAL MUSEUM
PAMBANSANG MUSEO

**REPUBLIC OF THE PHILIPPINES**
**OFFICE OF THE PRESIDENT**
**National Museum of the Philippines**
**P. Burgos St., Manila**

January 14, 2016

# CERTIFICATION

This is to certify that the shell specimens were identified as:

Class Gastropoda
Family Thiaridae
*Melanoides tuberculata* (Muller, 1774)

This certification is issued upon the request of Edzel V. Pares, Alessandro R. Galang and Eljohn Dave P. Camposano 4th year BS Environmental Science students from Technological University of the Philippines.

Vivian D. Ang
**VIVIAN D. ANG**
Museum Researcher II
Zoology Division

**Control #: CONCHO 2016-5**
**OR #**