Ethiopian TVET-System

Water supply and sanitation operation

Level-II

Based on Feb, 2017G.C. Occupational Standard

Module Title: Sampling and Testing water Quality

TTLM Code: EIS WSO2 TTLM 0920v1

September 2020

USAID FROM THE AMERICAN PEOPLE
jhpiego Johns Hopkins University Affiliate
Save the Children

This module includes the following Learning Guides

LG17: Conduct water quality sampling

LG Code: EIS WSW2 M05LO1-LG_17

LG18: Conduct water quality tests

LG Code: EIS WSW1 M05 LO2-LG_18

LG19: **Conduct basic waste-water tests.**

LG Code: EIS WSW1M08LO3-LG_19

LG20: **Finalize work.**

LG Code: EIS WSW1M08LO3-LG_20

Instruction Sheet-1	Learning Guide 17 Conduct water quality sampling

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Developing sampling plan documents
- Selecting and checking sampling equipment.
- Collecting samples according to sampling plan
- Maintaining integrity of samples
- Checking and recording sample information
- Recording results of repeated sampling

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Develop sampling plan documents that required samples, sampling locations and sampling schedules
- Select and check appropriate sampling equipment for the task prior to use
- Collect samples according to sampling plan and ensure safety procedures
- Maintain integrity of samples
- Check and record sample information
- Record results of repeated sampling to identify trends

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 6”. Try to understand what are being discussed.
4. Accomplish the “Self-checks 1,2,3,4 ,5 and 6” in each information sheets on pages 4,11,14,19,23 and 26.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).

6. If you earned a satisfactory evaluation proceed to “Operation sheets 1, 2 and 3 on pages 28,29 and 30.and do the LAP Test on page 31”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG.

Information Sheet-1	Developing Sampling Plan Documents

1.1. Introduction to developing sampling plan documents

A sampling plan is a detailed outline of which measurements will be taken at what times, on which material, in what manner, and by whom. Sampling plans should be designed in such a way that the resulting data will contain a representative sample of the parameters of interest and allow for all questions, as stated in the goals, to be answered.

The accuracy of water quality results obtained in the laboratory is just as dependent on the correctness of the sampling technique as it is dependent on the accuracy of the analytical procedures. Therefore the sampling exercise requires careful planning beforehand.

Before any sampling program is started, it is important to define clearly the objectives of the

sampling program as this will dictate issues such as:

- The substances to be sampled and analyzed
- The frequency of sampling
- The choice of preparatory steps prior to analyses
- The appropriate guidelines to evaluate the results.
- Which substances in the water are of interest
- Where and when are samples to be taken
- how are samples to be taken
- Which analytical methods are to be used
- How results are to be reported; and
- What is to be done with the reported results.

1.2. Types and purpose of water samples

The two types of water samples typically to be taken are grab samples and composite samples. Grab samples are usually taken when you want information specific to a particular sampling location, time or distinct areas within a sampling location.

Composite samples are usually taken when we want an average representation of a sampling location or time. For example, if we want to know how water chemistry varies within a lake, then we will take a number of grab samples. If we don't care how the chemistry varies within the lake, but just want to know the "average" water quality of the lake, we can take a composite sample from several locations.

A properly taken grab sample is a snap shot of the quality of the water at the exact time and place the sample was taken. Depending on the water body, grab samples may be taken by simply dipping a sample bottle in the water body, or they may require the use of specific sampling devices.

- **Grab Samples**

The simplest, a “grab” sample, is taken at a selected location, depth and time. Normally, the quantity of water taken is sufficient for all the physical and chemical analyses that will be done on the sample. Sometimes, if the sampler is small and many analyses are to be done, two grab samples will be taken at the station and will be mixed in the same transport container. Grab samples are also known as “spot” or “snap” samples.

There are two types of grab samples that are used for sampling water matrices: discrete and depth-integrated.

The ***discreet*** grab sample is one that is taken at a selected location, depth, and time and then analyzed for the constituents of interest.

A ***depth-Integrated*** grab Sample is collected over a predetermined part or the entire depth of the water column, at a selected location and time, in a given body of water, and then analyzed for the constituents of interest.

The primary advantage of grab samples is that sometimes very little equipment is required for sample collection and there is flexibility in sampling location selection. However, this method sacrifices data resolution because of the smaller number of samples that are usually collected

- **Composite samples**

A composite sample is a mixture of grab samples taken at different times or locations and pooled together to provide one sample. Composite samples may be of the following types:

- **Area-integrated**: made by combining a series of samples taken at various sampling points spatially distributed in the water body (but usually all at one depth or at predetermined depth intervals).
- **Time-integrated**: made by mixing equal volumes of water collected at a sampling station at regular time intervals.

- **Discharge-integrated**: It is first necessary to collect samples and to measure the rate of discharge at regular intervals over the period of interest. A common arrangement is to sample every 2 hours over a 24-hour period. The composite sample is then made by mixing portions of the individual sample that are proportional to the rate of discharge at the time the sample was taken
- **Depth-integrated**: most commonly made up of two or more equal parts collected at predetermined depth intervals between the surface and the bottom. A piece of flexible plastic piping of several meters in length, and which is weighted at the bottom, provides a simple mechanism for collecting and integrating a water sample from the surface to the required depth in a lake.

1.3. Advantages and Disadvantages of Composite Samples

Advantages of composite samples include reduced costs of analyzing a large number of samples, more representative samples of heterogeneous matrices, and larger sample sizes when amounts of test samples are limited.

It also gives you an idea of the average condition of a water body over time, (samples taken at different times and mixed together) or space, (samples taken at different locations within the water body). This is particularly useful in water bodies that have a lot of chemical variability either over space or over short time periods. Composite samples are often used to reduce the cost of analyzing a large number of samples

Disadvantages of composite samples include loss of analyte relationships in individual samples, potential dilution of analytes below detection levels, increased potential analytical interferences, and increased possibility of analyte interaction.

1.4. Methods of Sampling

- **Manual Sampling**: Manual sampling involves minimal equipment but may be unduly costly and time-consuming for routine or large-scale sampling programs. It requires trained field technicians and is often necessary for regulatory and research investigations for which critical appraisal of field conditions and complex sample collection techniques are essential.
- **Automatic sampling**: Automatic samplers can eliminate human errors in manual sampling, can reduce labor costs, may provide the means for more frequent sampling and are used increasingly. Be sure that the automatic sampler does not contaminate the sample.

1.5. Sampling Locations

Water samples are collected from locations which are representative of the water source. Locations for collecting water sampling can be described as:

- **Raw water supply** which includes surface water and ground *water* supply.
  - **Surface Water supply**: Surface water sources are divided into flowing and standing water. The sampling frequency at these two types of water resources differs. Rivers and streams are more susceptible to sudden water quality changes than lakes and dams.

    Thus, more frequent samples are needed from a river or stream than from a lake or dam. Surface water supply sources include rivers, streams and lakes.

  - **Groundwater supply**:

    Ground water is a type of water found in the ground seeps down through the soil until it reaches rock material that is saturated with water. Water in the ground is stored in the spaces between rock particles. This type of water can be used for taking water samples.
- **Water distribution and treatment systems.**

Are ways of controlling the flow and direction of both surface and ground water**.** They are the link between the water supply source and the consumer.

Water samples are taken at the outlet of treatment works to check the treatment processes and/or the quality of the water supplied to the consumer.

Water within a distribution system is normally sampled to evaluate and check whether the distribution system performs correctly. If overall performance of the distribution system needs to be evaluated it is better to take the sample from a pipe with significant flow, rather than from a stagnant section of the distribution system. For contamination, monitoring samples must be collected down-flow of the (suspected) point of contamination in the distribution system.

1.6. Safety Precautions for Water Sampling

While safety is often not considered an integral part of the sampling program, the sampler must be aware of possible unsafe working conditions, hazards associated with the operation of sampling gear, and other risks.

Basic good practice should be followed in the field. Always keep the following points in mind –

- Wear appropriate PPE
- Never drink the water you are about to sample unless you are very sure about the quality and safety of the water.
- Many hazards lie out of sight on the bottom of dams, rivers and streams. Broken glass or sharp pieces of metal embedded into the substrate can cause serious injury if care is not exercised when working in such environments**.**
- A clean pair of new, non-powdered, disposable gloves will be worn each time a different location is sampled and the gloves should be donned immediately prior to sampling.
- The gloves should not come in contact with the media being sampled and should be changed any time during sample collection when their cleanliness is compromised.
- Sample containers for samples suspected of containing high concentrations of contaminants shall be stored separately.
- Samplers must use new, verified and certified-clean disposable or non-disposable equipment cleaned according to work operating procedures
- Maintain decontamination and contamination free zones properly
- Contain all contaminated PPE and sampling equipment for disposal or decontamination.

1.7. General Rules of Sampling

In taking water samples from different sources take extra care to avoid contaminating the sample container and water sample.

Do not:

- Contaminate the bottle by touching the inside of the bottle.
- Contaminate the bottle lid by touching the inside rim.
- Put the bottle lid on the ground while sampling.
- Transport aquatic facility water samples with other water samples, e.g. effluent or drinking water**.**

Always:

- Collect microbiological samples before collecting other samples.
- Label the bottle before sampling.
- Discard damaged or contaminated bottles. If in doubt throw it out and take sample in a new bottle.
- Wash your hands thoroughly before and collecting samples.

Self-Check -1	Written Test

Direction I: Choose the best answer for the following questions. Use the Answer sheet provided in the next page: Each question worth one point

1. Which step is considered developing sampling plan?

A/ Selecting sampling size B/Identifying of parameters

C/ Design of sampling scheme D/ All

2. Which one of these is **not** a disadvantage of composite samples?

A/ Loss of analyte relationships in individual samples

B/ Reduced costs of analyzing of samples

C/potential dilution of analytes below detection levels

D/ Increase the possibility of analyte interaction.

3---------- is a type of sample usually taken when you want information specific to a particular sampling location, time or distinct areas within a sampling location:

A/ Composite sample B/ Grab sample C/ Analyte D/ All

4. Types of samples usually taken when we want an average representation of a sampling location or time are-------. A/Grab sample B/ Composite sample C/ Discreet grab sample D/ None

5. A properly taken grab sample is a snap shot of the quality of the water at the exact time and place the sample was taken.

A/ True B/ False

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5points**

Answer Sheet-1

Name: _____ Date: _____

Choice Questions

Score = _____

1_____ 4._____

2._____ 5._____

3_____

Information Sheet-2	Selecting and Checking appropriate Sampling Equipment

2.1. Introduction

Water sampling equipment is used to collect water samples from different water supply sources. The type of sampling equipment used for groundwater depends on the type of well, depth to water from ground surface, physical characteristics of the well, groundwater chemistry, and the analytes targeted for study.

Selecting the appropriate equipment for collecting of water samples from various sources is important in order to obtain data that will meet study objectives and data-quality requirements.

2.2. Selection of Sample Containers: Sample containers must be thoroughly clean so that they do not contaminate the samples placed in them.

Containers for the transportation of samples are best provided by the laboratory. This ensures that large enough samples are obtained for the planned analyses and that sample bottles have been properly prepared, including the addition of stabilizing preservatives when necessary. It is essential to have enough containers to hold the samples collected during a sampling expedition.

Sample containers should be used only for water samples and never for the storage of chemicals or other liquids.

2.3. Types of Sampling Equipment's

Sampling equipment used to collect samples from different sources should be with the proper design and quality. equipment which are required for collecting raw water sample from the surface, ground or other sources are listed below.

- **Buckets or wide-mouthed containers**: A plastic bucket can be used to collect samples for measurement of water quality parameters such as pH, temperature, and conductivity. Typically, a bucket is used to collect a sample when the water depth is too great for wading, it is not possible to deploy a boat, or access is not possible and the water column is well mixed.

- **Submersible pumps** can be used to collect surface water samples directly into a sample container. The constituents of interest should be taken into consideration when choosing the type of submersible pump and tubing to be used
- **Open-mouth samplers;** Are used for the collection of water samples include the hand-held bottle, the weighted-bottle sampler, the biochemical oxygen demand (BOD) sampler, and the volatile organic compound (VOC) sampler.
- **Depth samplers:** The depth sampler, which is sometimes called a grab sampler, is designed in such a way that it can retrieve a sample from any predetermined depth.
  It consists of a tube, approximately 10 cm in diameter and 30 cm in length, fastened to a frame along which it can slide.

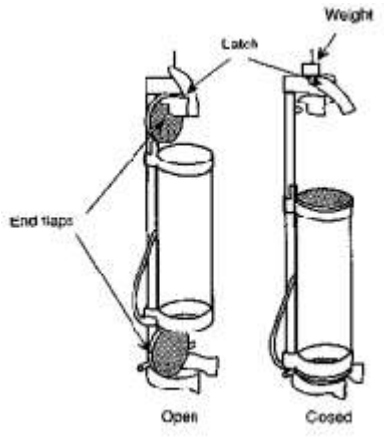


Fig.2.1. Depth sampler

- **Sample dippers**: Are small and long handled dippers for easy water sampling of hard to reach areas.
- **Sterile sample containers**: Are sample containers designed for collecting samples for microbiological testing. These are free from microorganisms contamination.
- **Weighted sample bottles:** is available in stainless steel or polyvinyl chloride. An open bottle is inserted into a weighted holder that is attached to a hand line for lowering.
- **Dip tubes:** A glass or plastic device used for collecting samples.
- **Sludge Sampler:** A sludge sampler is used to sample a profile of sludge in a basin. The tube is inserted into the sludge blanket. The tube then fills with sludge. The top of the tube is sealed and withdrawn from the basin.

Self-Check -2	Written Test

Direction I: Choose the best answer for the following questions. Use the Answer sheet provided in the next page:

1. Water sampling equipment:

A. Should be with proper design

B. Should hold proper volume

C. Should be easily manageable

D. All

2. Water samples can be collected from sample source using:

A. Refrigerators

B. Sampling equipment

C. Handling tools

D. All

3. _____ is used to collect a sample when the water depth is too great for wading.

A. Dip tubes B. Bucket C. Submersible samplers D. Sample dippers

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet-1

Name: _____ Date: _____

Choice answer sheet

Score = _____

1_____

2._____

3_____

Information Sheet-3	Collecting Samples according to Sample Plan

3.1. Introduction to collecting sample

In order to ensure the high quality and reliability of water quality results, a water quality sample must be collected in a manner that follows a standard procedure. Preparation and training are required to collect samples to accurately reflect the water quality at a particular site and to preserve the sample during handling and transportation to the laboratory. Subtle deviations may influence results that will be used in making decisions regarding public health.

3.2. Water Samples Collection

It is important to collect water samples under normal, everyday conditions in order to gain a representative sample. Proper procedures for collecting samples must also be observed. Technicians should be properly trained since the way in which samples are collected has an important bearing on the tests results.

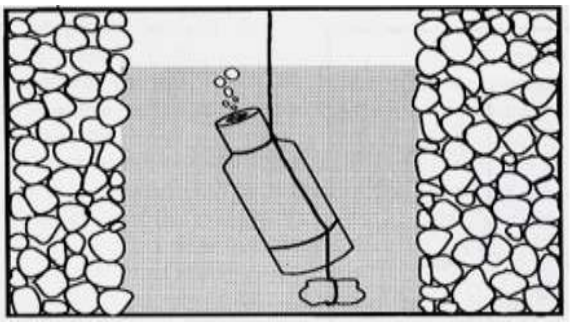


Fig.3.1 Lowering a weighted bottle in to a well

In obtaining water samples we have to be careful in selecting in choice the type of bottles.

It is important when undertaking sampling, particularly for trace analytes, that the sampling equipment is inert, that is, it does not cause contamination or interference with the sample.

For example, if the water sample is being collected to determine the presence of trace metals (e.g. copper or zinc) in the water, do not use sample bottles with metal components (e.g. metal caps).

When sampling for organics, avoid using sample bottles with plastic components, as the Plasticizers may leach and contaminate the samples.

Samples should be collected in a non-reactive borosilicate glass, plastic bottle or plastic bag that has been cleaned, rinsed and sterilized. A sample container is usually provided as part of portable field kits. Disposable Whirl-pak® sample bags are another option to collect water samples.

Whirl-pak® Sample Bag

Fig3.2.Sample bag

Plastic Sample Bottles

Fig.3.3.Sample bottles

.

- **Sampling a Surface Water Source**

When the water body is shallow and well mixed, sub-surface water sampling is generally adequate. Sub-surface samples should be taken from approximately 30 cm depth, with care taken to ensure no floating films or organic material are collected unless they are of specific interest.

You should try to obtain samples that are representative of the source of the drinking water supply. Do not take samples that are too near the bank, too far from the point of draw off, or at a depth above/below the point of draw off. Water quality can change depending on the time of day or season.

It is important to sample at the same time of day and record the weather conditions when you are taking your sample. It may be possible to take samples by hand if it is easy to get the water. In many cases it may be inconvenient or dangerous to enter the water source such as river, pond or canal. In these cases, you may need to tie your container to a piece of wire or rope and throw it into the water.

When sampling by hand, surface films can be avoided by removing the cap, inserting the container into the water vertically with the neck facing down. Once at the required depth, the container can then be inverted, allowing the sample to flow in.

The mouth of the container should be faced into the current while keeping the hands, sampler and any other equipment downstream to minimize the chance of contamination.

Fig.3.4. Locating and Identifying correct sample site

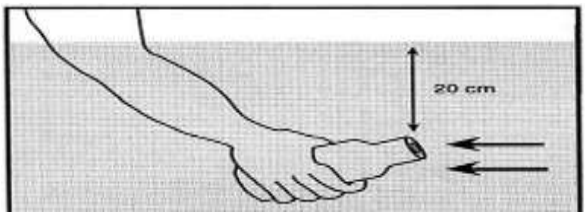


Fig.3.5..Collecting a sample from surface water

Sample handling and sample transport are important aspects of water quality sampling that are often neglected.

As soon as the water sample has been collected some of the chemical characteristics of the water start to change. For this reason some samples must be preserved to keep the quality of the water sample as stable as possible until the analysis can be carried out. It must, however, be kept in mind that the preservation technique only retards chemical and biological changes that continue after sample collection and will not stop quality changes altogether.

- **Sample Handling and Preservation Requirements**
  - To minimize water quality changes between sampling and analysis it is important to keep the samples as cool as possible, without freezing them..
  - Chemical samples will be kept cool and analyzed at a laboratory within 7 days of sampling. This technique excludes the physical measurements that are taken on site, and microbiological samples that must be analyzed within 6 hours of sampling if not cooled, and within 24 hours if cooled.

- During sample collection, if transferring the sample from a collection device, make sure that the device does not come in contact with the sample containers.
- Place the sample into appropriate, labeled containers.
- All samples requiring preservation must be preserved as soon as practically possible, ideally immediately at the time of sample collection.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

TRUE OR FALSE ITEMS

1. For microbiological testing 100 ml is the minimum volume of sample to be taken as a sample to obtain reliable results.
2. Ensure that you don't touch any part of your face while doing the tests
3. Washing hands before and after doing any bacteriological testing is not necessary.
4. Any type of plastic bottles can serve for sampling purposes.
5. Preparation and training are required to collect samples to accurately reflect the water quality at a particular site.

Note: **Satisfactory rating - 5 points** **Unsatisfactory - below 5points**

You can ask you teacher for the copy of the correct answers.

Answers for True or False item

1._____ 2._____ 3._____, 4_____, 5_____

Information Sheet-4	Maintaining Integrity of samples

4.1. Introduction to maintaining Integrity of samples

Ensuring sample integrity is critical in laboratory and pharmaceutical research, microbiology, food technology, forensics, water quality testing and many other scientific applications.

To ensure that sampling is consistent, and of good quality and traceability, samples need to be representative of the body from which they were taken. If the sample integrity is altered, the information gained from analysis could be misleading and ultimately result in mismanagement of water resources and/or polluting of the resource.

Collecting integrated samples is a complicated and specialized process that must be described adequately in a sampling plan..

Fundamental to water-quality sampling is the fact that the quality of the analytical results can be no better than the quality of the sample on which the analyses were performed. The sample collector has primary responsibility for the quality and integrity of the sample up to the time that the sample is delivered to the analyzing laboratory or office. Data quality is determined from analysis of quality-control data.

4.2. Requirement for maintaining integrity of samples

In order to maintain sample integrity, the sample should be with:

- Adequate volume
- Correct handling procedure.
- Free from contamination
- Good labeling.
- Correct holding time
- Storage procedures
- sub-sampling procedure

- **Correct holding Times**

The integrity of the sample is dependent on strict adherence to standard operating procedures in place in the laboratory. Sample holding times are determined by the analytical method.

Samples received after the holding time has expired are analyzed only under direct request from the client.

Appropriate sample and/or data qualifiers are noted on the final report, as while preservation techniques can reduce degradation rates, they may not completely halt such changes. All analytes therefore have a holding time, which is the maximum time that can elapse between sampling and analysis, and where the sample is unlikely to be significantly modified under the recommended preservation conditions. Samples must be delivered to the laboratory within the required holding times.

- **Sample Storage Prior to Analysis**

All samples are properly stored from the time they arrive at the laboratory to disposal. Samples are refrigerated at 4ºC prior to analysis unless method of standard operating procedures indicates other storage conditions.

- **Nature of Sample Changes**: Some analyses are more likely than others to be affected by storage before analysis. Certain cations are subject to loss by absorption or ion exchange with the walls of glass containers. These include aluminum, cadmium, chromium, copper, iron, lead, manganese, silver, and zinc, which are best collected in a separate clean bottle and acidified with nitric acid to a pH below 2.0. This minimizes precipitation and absorption to container walls.

Temperature, pH, and dissolved oxygen are best determined in the field. Temperature changes quickly and pH may change significantly in a matter of minutes.

Dissolved gases (oxygen, carbon dioxide) may be lost very quickly. With the changes in the pH-alkalinity-carbon dioxide balance, calcium carbonate may precipitate and cause a decrease in the values for calcium and total hardness

Biological changes taking place in a sample may change the oxidation state of some constituents. Soluble constituents may be converted to organic bound material in cell structures, or cell lysis may result in release of cellular material into solution.

- **Sample Disposal:** All samples are disposed in an environmentally sound manner or returned to the client upon request. Samples may also be returned to the client if they contain hazardous wastes.

Samples that contain solvents are evaporated in a fume hood unless the vapors create an environmental concern. Samples that contain hazardous materials, such as mercury and silver, are sent to a hazardous waste collection facility.

The remaining samples are stored in a holding tank that is transferred to a Wastewater Treatment Facility for proper disposal. Samples are typically stored for 30 days following the report date unless otherwise instructed by the. client.

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Part I. True or False items

1. All samples should be collected with enough time for analysis within the holding time of desired analysis.
2. Sample containers can be used for sampling before they are inspected for cleanliness and integrity.
3. Biological changes taking place in a sample may change the oxidation state of some constituents.
4. All samples should be properly stored from the time they arrive at the laboratory to disposal.

Part II. Multiple choice items

5. If the sample integrity is altered:

A/ the information gained from analysis could be misleading
B/ ultimately result is deceptive
C/ Will not be representative of the sample source
D/ All

6. Which one of these is incorrect to maintain the integrity sample?

A/Correct handling procedure C/Free from contamination
B/Inadequate volume D/Good labeling

Note: **Satisfactory rating – 9 and above points** **Unsatisfactory - below 9 points**

You can ask you teacher for the copy of the correct answers.

Name: _____ Date: _____

PART I. True or True items

Score = _____

Rating: _____

I._____

2._____

3._____

4._____

II. Multiple Choice items

5._____ **6.**_____

Information Sheet-5	Checking and Recording Sample Information

5.1. Introduction to Checking and Recording Sample Information

It is crucial for each sample bottle to have a clearly identifiable label when arriving at the laboratory. Labels printed on special water-resistant paper should preferably be used. The label should be completed with a waterproof pen immediately after the sample is taken and tied to the neck of the bottle with a piece of string with the following information written on the label a unique sample number and description.

- The date and time of sampling (Remember day/month/year).
- The name of the sampler.

Collected water samples for study or analysis purposes should be labeled with proper information prior to use**.** The sample information should be recorded correctly and precisely on prepared recording formats such as field sheet details, log books or chains of custody

- **Field sheets:**
  - ✓ Reminder of where and what need to sampled/measured
  - ✓ Permanent record of sample details
  - ✓ Record of field measurements
  - ✓ Observations
  - ✓ Deviations
- **Information to be filled in a field Sheet**
  - ✓ Sampling location (name and/or code)
  - ✓ Sampling date and time
  - ✓ Name & signature of sample collector
  - ✓ Results of field measurements e.g. Temp, pH
  - ✓ Types of samples taken (general chemical, metals,)
  - ✓ Details of any preservative used
  - ✓ GPS readings – if new location or non-routine site
  - ✓ Observations – weather, visual inspection
  - ✓ Deviations

Table 1.Sample recording and reporting formats

LOCATION: _____ SAMPLES TAKEN BY: _____

DATE OF SAMPLING: _____Day____ Month_____ Year_____

TIME OF SAMPLING: _____Hour _____Minute_____

SAMPLE TESTED BY: _____

Purpose of Sampling_____

Sample Description	Sample ID #	Color	Temp.	Turbidity	PH	TDS	EC	Fecal Coliform (CFU/100ml)	Total Coliform (CFU/100ml

DATE OF REPORT: _____

COMMENTS**:**_____

- **Data sheets:** Data sheets make provision for recording the physical and environmental information of the sampling point. This information is needed to interpret water quality at a site especially if the water quality results obtained from the laboratory indicate a sudden change.

Self-Check -5	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

TRUE OR FALSE ITEMS

1. Water samples for analysis purposes should be labeled with appropriate information after it is tested.

2. The labeling of samples be completed with a waterproof pen immediately before the sample is taken.

3. Data sheets make provision for recording the physical and environmental information of the sampling point.

Note: **Satisfactory rating – 3 and above points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet-5

Name: _____ Date: _____

Part:-Short answer

1._____

2._____

3._____

Information Sheet-6	Recording Results of Repeated Sampling

6.1. Introduction to recording repeated Sample results

It is important to take accurate records of analyzed water sampling results properly.

After analyzing the testing values of repeated sample water results, the data which is obtained should be recorded on log books, recording formats or other data recording forms. It is imperative to store sample results in a computer or filled in printed paper forms to make reports and logs. The records of results are containing valuable information which can serve for further decision making and quality improvisation of the system. It also helps in creating conducive communication environment between clients, regulating bodies and decision makers.

1.2. Sample Records information

sample records, field detail sheets or chain of custody forms, include information such as:

- time sample was taken
- Person collecting sample
- sample point location
- volume of sample collected
- data gathered at time of collection
- preservation methods employed
- instructions to transporters
- time and logging of sample receipt and testing
- equipment identification
- atypical test results

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I.TRUE OR FALSE ITEMS

1. The results of sample data can be recorded in a field detail sheets.
2. No need of recording sample point location in a chain of custody forms
3. Sample observations should be included as well and describes anything unusual about the water.

Answer Sheet-6

Name: _____ Date: _____

Short Answer Questions

Score = _____

Rating: _____

1._____

2._____

3._____

Note: **Satisfactory rating – 2 points Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Operation Sheet 1	Sampling Preparation

Procedures for Sample plan preparation

Step1.Determine the purpose of your sampling

Step 2. Identify the site location for sampling

Step3.Select tools and equipment

Step4.Select required safety equipment

Operation Sheet 2	Surface water sampling

Procedures for collecting water sample from River, Stream or lake.

Step1.At the sampling point remove cap of sample bottle but do not contaminate inner surface of cap and neck of sample bottle with hands

Step 2.Take samples by holding bottle with hand near base and plunge the sample bottle, neck downward, below the water surface (wear gloves to protect your hands from contact with the water).

Step.3.Turn bottle until neck points slightly upward and mouth is directed toward the current (can also be created artificially by pushing bottle forward horizontally in a direction away from the hand)

Step 4.Fill sample bottle without rinsing and replace cap immediately.

• Before closing the sample bottle leave ample air space in the bottle (at least 2.5 cm) to facilitate mixing by shaking before examination.

Step 5. Complete label and sample sheet

Operation Sheet 3	Sampling from an Open Well

Procedures for collecting samples from an open wall

. **Step1**. Prepare the appropriate sample container

Step 2. Fasten a cable, rope or string to the sample container.

Step 3. Lower the sample container into the well or tank, taking care not to allow the container to touch the walls of the structure where it may pick up dirt.

Step 4. Submerge the container to a depth of 30 cm.

Step 5. Lift the sample container carefully and place on a clean surface.

Step 6. Proper sample labeling.

LAP Test	Practical Demonstration

Name: _____ Date: _____

Time started: _____ Time finished: _____

Instructions: Giving the necessary equipment and PPEs you are required to perform the following tasks within 3 hours.

Task1. Prepare Sample planning

Task2. Sampling from an Open Well

Task3.Sampling from a river or lake

Task4. Sample labeling

Task5. Sample Reporting

Instruction Sheet-2	Learning Guide #18 Conduct water quality Testing

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Receiving and confirming instructions for water quality test and plan testing work.
- Conforming testing details and plan testing work
- Preparing and checking required testing equipment
- Selecting, checking and using PPE for routine tests.
- Identifying and recording correct samples for testing
- Conducting Water quality tests

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Receive and confirm instructions for conducting and recording water quality test and plan testing work.
- Confirm testing details and plan testing work
- Prepare and check required testing equipment.
- Select, check and use specified personal protecting equipment for routine tests
- Identify and record correct sample for testing.
- Conduct water quality tests according to procedures and ensure maintaining of sample integrity during the process.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 6”. Try to understand what are being discussed. Accomplish the “Self-checks 1,2,3,4, 5 & 6” in each information sheets on pages 36,38, 41, 45, 47, & 55.
4. If you earned a satisfactory evaluation proceed to “Operation sheets 1, 2,3, 4, 5, 6, 7, 8. on pages 56,58,59,60, 61,62,63 64. and do the LAP Test on page 65”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
5. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; then proceed to the next LG.

Information Sheet-1	Receiving and confirming Instructions for conducting Water Quality Test and Plan Testing

1.1. Introduction

Water is in continuous movement on, above, and below the surface of the earth. As water is recycled through the earth, it picks up many things along its path. Water quality will vary from place to place, with the seasons, and with the various kinds of rock and soil it moves through.

Water quality testing is a tool that can be used to help identify safe drinking water whether at the source, within a piped distribution system, or within the home.

Water testing plays an important role in monitoring the correct operation of water supplies, verifying the safety of drinking water, investigating disease outbreaks, and validating processes and preventative measures.

Water quality testing can be defined by three broad categories:

- Physical: Such as Color, taste, odor, temperature and total solids
- Chemical: Such as p^H, hardness, alkalinity, cation's and anions, dissolved gases.
- Biological attributes such as bacteria, viruses, protozoan, Helminths'.

Water quality testing can also be carried out in different locations such as on-site testing, field-based testing and laboratory-based testing depend on the availability of conditions and requirements.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

Choose the best answer (Each question worth 2 points)

1. Which is correct about safety precautions in the laboratory?

   A. Do not pipette by mouth C. Use PPE as required

   C. Keep your work area tidy and clean D**.** All.

2. Before collecting samples, make sure you have all the proper:

A. bottles, B. field equipment C. Preservatives D. All

3. A Set up of laboratory which can provide service on in a suitable motor vehicle or truck is termed as----------

A. On-site laboratory B. Basic laboratory

C. Mobile laboratory D. Conventional laboratory

4. Properties of water that usually recognized by our senses is termed as_____

A. Biological properties B. Chemical properties C. Physical properties D. None

5. Types of laboratories which uses international standards for testing provide more consistent, accurate and precise results are known as----------.

A. Commercial laboratory B. Conventional Laboratory

c. On-site laboratory D. Mobile laboratory

Answer Sheet-1

Name: _____ Date: _____

Part:-Short answer

1._____ **4.** _____

2._____ **5 .**_____

3._____

Information Sheet-2	Confirming test details and plan testing work

2.1. Introduction to confirming test details and plan testing work

2.1.1. Planning testing work

In conducting water quality tests, test details are to be determined according to organizational and safety requirements. According to this:

- **Timelines**: Testing timelines are essential to ensure that the testing schedule is transparent and well planned. The time line is composed of a series of tasks, each of which has a due date and duration. A successful laboratory timeline helps to maintain a productive and engaged team to work together toward a common goal to seize success. A poor time line, on the other hand leads to confusion, missed deadlines, waste costs, and un happy clients.
- **Variety of samples:** A number of commercial laboratories carry different water quality packages that include a variety of tests to assess water potability. There are basic tests such as testing for bacteria, nitrate, ph, sodium, manganese, total dissolved solids, Hardness and e.tc. on the other hand comprehensive types of testing are recommended for testing Rural Water Sources for Drinking and Domestic purposes.
- **Locations for testing**
  - ✓ **Commercial Laboratory**: These laboratories are usually located in larger cities and have dedicated facilities, trained technicians and specialized equipment. Laboratories use international standards for testing and can provide more consistent, accurate and precise results
  - ✓ **Conventional Laboratory** Water quality testing can also be carried out in a laboratory. This method requires facilities, trained technician, equipment and other supporting materials Laboratory testing can be useful if you are only taking a small number of samples and your project is located close to an urban area where a laboratory is present.
  - ✓ **Mobile Laboratory Testing** It is possible to set up a laboratory in a suitable motor vehicle, e.g. truck or van. In effect, this is a variant of field testing, but may provide better facilities than test kits. In practice, it is only feasible where projects are scattered in different locations and they have common water quality monitoring. Government

agencies and research centers responsible for monitoring and water quality testing sometimes use mobile laboratories for periodic water quality testing.

- **Organizational legislatives and safety requirements**

✓ **Guidelines**: Guidelines are intended to support the development and implementation of risk management strategies that will ensure the safety of drinking-water and treated waste water supplies through the control of hazardous constituents of water.

The Guidelines describe reasonable minimum requirements of safe practice to protect the health of consumers and derive numerical "guideline values" for constituents of water or indicators of water quality.

When defining mandatory limits, it is preferable to consider the Guidelines in the context of local or national environmental, social, economic and cultural conditions.

✓ **Lab Safety Precautions**

It is important to work safely and avoid injuries while carrying out water quality testing. It is the responsibility of the training provider to provide safety equipment, but it is the responsibility of each trainee/individual to use the equipment properly and to request equipment if it is not available. It is also the responsibility of the trainer to provide safety training to anyone involved in water sampling and testing.

The following are rules that relate to almost every laboratory and should be included in most safety policies. They cover what you should know in the event of an emergency, proper signage, safety equipment, safely using laboratory equipment, and basic common-sense rules.

- ✓ Keep your work area tidy and clean.
- ✓ Make sure that all eye wash stations, emergency showers, fire extinguishers, and exits are always unobstructed and accessible.
- ✓ Keep materials only you require for your work in your work area.
- ✓ Solids should always be kept out of the laboratory sink.
- ✓ Do not chew gum, drink, or eat while working in the lab.
- ✓ Laboratory glassware should never be utilized as food or beverage containers.
- ✓ Never smell or taste chemicals.
- ✓ Do not pipette by mouth.
- ✓ Follow proper procedures for disposing lab waste

Information Sheet-3	Preparing and Checking Water Quality Testing Equipment

3.1. Introduction to Water quality testing equipment

Water quality testing equipment's are used to evaluate the quality of water. These equipments are with different sizes, designs and applications. Selection of equipment for collecting or processing water-quality samples depends on the physical constraints and safe operation of the equipment and on its suitability with respect to achievement of study objectives.

Criteria for preparing and selecting equipment for water sampling depend on

- ✓ the mechanical constraints of the equipment to perform adequately under given environmental conditions,
- ✓ the adequacy of equipment operation to obtain water-quality samples that represent the environmental conditions of the sample source, and
- ✓ the adequacy of the equipment materials and construction to maintain sample integrity and not to be a source of leaching and sorption of target analytes.

3.2. Preparing water quality testing equipment's

Different testing equipment that are used in water and wastewater quality lab should be checked and prepared before taste is commenced. Some of this testing equipment include portable meters PH meters, Electrical conductivity meter, Comparators, Pocket colorimeters, dissolved oxygen meters, Test kits, Thermometers, Graduated cylinders and settling apparatus.

- **Purpose of some common water testing equipment**

  - ✓ **Spectrophotometer** - For physico-chemical analysis
  - ✓ **Incubator & Accessories** - For microbiological analysis.
  - ✓ **Conductive meter** - For measurement of EC & TDS.
  - ✓ **Turbidity meter** - For measurement of turbidity.
  - ✓ **P^H meter** – For measurement of P^H value
  - ✓ **Flock Tester /Jar Test/-** For determination of the quantity chemicals.

- ✓ **Color comparator** -For determination of Residual Chlorine

Table.3.1.Some Common Laboratory testing equipment

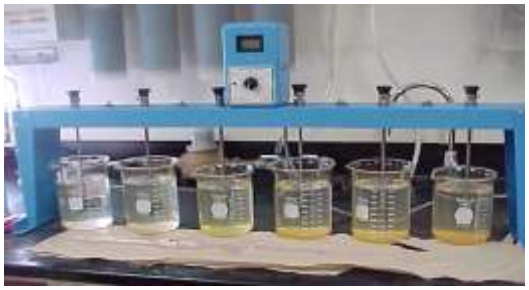
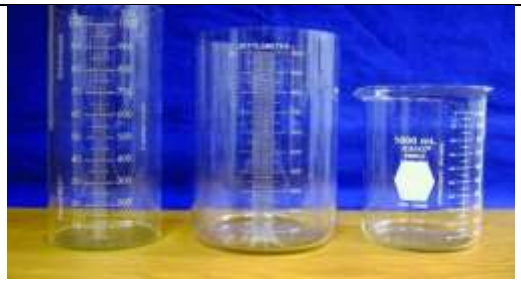
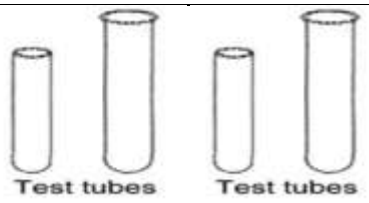
S.No.	Name of equipment	Apparatus/Equipment
1	**p^H meter**	 
2	**Turbidity meter**	
3.	**Spectrophotometer**	
5.	**Jar Test apparatus**	
6	**TDS meter**	
7.	**Color Comparator**	
8.	**Digital multi-meter**	

Table3. 2. Common laboratory glass wares

S.No.	Name of Glass wares	Diagrams of glass wares
1.	Beakers	
2.	V3olumetric Flasks	
3.	Graduated Cylinders	
4.	Graduated beakers	
5	Test Tubes	

- **Common laboratory glass wares:** In the laboratory we conduct various types of water quality tests depending on their requirement. For conducting such types of quality testing

numerous numbers of testing tools, equipment's, reagents and laboratory glass wares are used. Some of the commonly used laboratory glass wares used for measuring volumes of liquids, for holding of samples and mixing purposes are indicated below.

- ✓ **Beakers:** Beakers are one of the multifunctionary laboratory equipment's used to hold samples, used for preserving small chemical reactions, and are used for pouring solutions easily
- ✓ **Test tubes:** Are convenient containers or equipment widely used by chemists, water quality laboratory technicians and other professionals to handle chemicals and samples for qualitative experiments**.**
- ✓ **Graduated cylinders:** Is a common laboratory equipment/flask used for measuring or mixing the volume of a liquid. It has a narrow cylindrical shape. Each marked line on a graduated cylinder represents the amount of liquid that has been measured.
- ✓ **Volumetric flasks:** It is a piece of laboratory apparatus or laboratory flask which is calibrated to contain a precise volume of liquids.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page:

I. Choose the best answer

1. Common laboratory equipment used for measuring or mixing the volume of a liquid.

   A. Beakers
   B. Test tube
   C. Graduated cylinder
   D. Volumetric flask

2. The cloudiness of water can be measured by a laboratory device of----------.

   A. Turbidity meter
   B. P^H meter
   C. Spectrometer
   D. Conductivity meter

3. The primary uses of bottles in the laboratory is:

   A. To store chemicals or solutions.
   B. To collect samples
   C. To conduct analyze
   D. All

4. _____ measures the acidity or basicity of a sample

   A. Turbidity meter
   B. Color comparator
   C. P^H meter
   D. Photometer
   E.

Answer Sheet-2

Name: _____ Date: _____

Short Answer Questions

1._____**2.**_____

3._____

4._____

Score = _____

Rating: _____

Note: **Satisfactory rating – 2 points** **Unsatisfactory - below 2 points**

Information Sheet-4	Selecting, Checking and using PPEs

1.1. Introduction to Personal Protective Equipment (PPE)

It is gear or clothing used to protect the wearer from specific hazards and hazardous materials. It is the final protection system to be used when administrative and engineering controls do not reduce risk to an acceptable level. PPE does not reduce or eliminate the hazard but only protects the wearer. Personal Protective Equipment (PPE) appropriate for the work conditions must be selected, checked and used properly when working with laboratory to prevent yourself from hazard.

While collecting samples or testing water quality tests at a work area select, check their proper quality and use the wisely according to organization requirements.

1.2. Commonly used PPEs in Water Testing

Safety glasses or splash goggles are used for Eye and Face Protection

- ✓ Gloves- Are used for hand/skin protection.
- ✓ Fully enclosed footwear- Are used for Foot Protection
- ✓ Apron/ Gowon/ For protection of Cloths
- ✓ Nose mask Used for Respiratory Protection

Respiratory protection stops dust, particles and chemical vapors. Always use this safety equipment when using chemicals or hazardous goods because dangers may not be obvious.

Fig.4.1.Nose Mask

Fig.4.2.Using of many PPEs

Self-Check -4	Written Test

Directions: Answer all the questions listed below.

TRUE OR FALSE ITEMS

1. Personal protective equipment used to protect the respiratory system is -----

A. Nose mask B. Gloves C. Goggles D. Apron

2. As fully enclosed foot wears are for foot Protection, gowns are to_____ Protection.

A. Mouth B. Head C. Cloth D. Eyes

Score = _____

Rating: _____

Note: **Satisfactory rating – 2 points Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet-4

Name: _____ Date: _____

Short Answer Questions

1._____

2._____

Score = _____

Rating: _____

Information Sheet-5	Identifying and Recording Correct Samples for Testing

5.1. Introduction to sample recording

In order to ensure the high quality and reliability of water quality results, a water sample must be collected with proper sampling materials in a manner that follows a standard procedure.

To accurately reflect the exact water quality at a particular site, the collected samples should be handled, preserved, transported and arrived to the laboratory on the allowed time. The collected samples should be with their proper labeling requirements

5.2. Identifications Correct Samples

Each sample bottle must be provided with an identification label on which the following Information is legibly and indelibly written:

- Name of the study.
- Name of sampler
- Sample station identification and/or number.
- Sampling depth
- Date and time of sampling.
- Brief details of weather and any unusual conditions prevailing at the time of sampling.
- Record of any stabilizing preservative treatment
- Location and name of sampling site (include GPS coordinates if available)
- Other observations that may affect the method or results of the analysis

5.3. Requirements of Correct samples

- Collected with an appropriate sampling material
- Containing of sufficient required volume
- Correct labeling
- Transported and Properly stored
- Time staying before testing
- Properly preserved
- Using of the right equipment for testing
- Using of the right reagents for testing

Self-Check-5	Written Test

Directions: Choose the correct answer of the given choices.

1. Which one of these is a requirement for correct sampling?

A. Collected with proper material
B. Should be labeled correctly
C. Should hold adequate volume
D. D. All

2. Collected samples of water should be:

A. Handled carelessly B. Transported properly
C. Mixed with other samples D. Stored at room temperature

3. Hazards exist in every workplace in many different forms:

A. True B. False

Score = _____
Rating: _____

Answer Sheet 5

Name: _____ Date: _____

True or False items

1. _____
2. _____
3. _____

Information Sheet-6	Conducting Water Quality Tests

6.1. Introduction to Conducting Water Quality Tests

The term water quality is generally used to describe the microbiological, physical and chemical properties of water that determine the fitness for use of a specific water source. Even though water may be clear, it does not necessarily mean that it is safe for us to drink. It is important to judge the safety of water by taking the following three types of parameters in to consideration.

- **Physical quality**: Refers to water quality properties (such as conductivity, pH and turbidity) that may be determined by physical methods. The physical quality mainly affects the aesthetic quality (taste, odour and appearance) of water.
- **Chemical quality**: Refers to the nature and concentration of dissolved substances (such as organic and inorganic chemicals including metals and non-metallic ions.). Many chemicals in water are essential as part of a person's daily nutritional requirements, but unfortunately above a certain concentration most chemicals (e.g. zinc, copper, manganese) may have negative health effects if they are beyond the recommended values of WHO and National water quality guidelines.
- **Microbiological quality**: Refers to the presence of organisms that cannot be individually seen by the naked eye, such as protozoa, bacteria and viruses. Many of these microbes are associated with the transmission of infectious water-borne diseases such as gastroenteritis and cholera.

6.2. Types of Laboratories for Water Quality Testing

Conventional laboratories were mainly used to carry out water quality testing. Now there is a wide variety of good testing kits and products available in the commercial market that allows you to conduct water quality testing on your own without relying on a laboratory. The following sections present the different methods that are available.

- **On-Site Testing:** This type of testing is carried out onsite when the communities or sampling sites are remote or inaccessible for commercial or other normal laboratories**.**

Conducting on site testing of samples has some advantages such as:

- Solving the deterioration of samples during transportation.
- Reduces high cost of transporting samples
- Limits inadequate techniques for sample storage and preservation during prolonged transport, thus limiting the sample range.

On site testing is carried out using portable testing equipments that can operate and manage easily. Portable equipment/Testing kits/ are used in many developing countries, and does help to overcome a number of logistic and financial constraints.

- **Portable Testing Kits**

Analyses for many physical, chemical and microbiological contaminants can be carried out in the field or in a temporary laboratory using specifically designed products that are portable and relatively easy to use

Figure.6.1.Mobile Laboratory Testing/Portable kit/

6.3. Common Types of Test Methods

The following methods, in order of complexity, are generally used to test chemical contaminants in the laboratory:

- **Colorimetric Method:** Chemical reagents are added to the water sample which react with the particular chemical parameter of interest. The product that is formed absorbs light at a particular wavelength. The water sample is then analyzed in a colorimeter or spectrophotometer and compared to known standards.

- **Electrode methods:** Ion-selective electrodes can measure the concentration of certain ions in the water sample. p^H value of a substance is easily measured with this Smethod.

- **Chromatography:** Samples are passed through a column containing a specific packing or coating that selectively retains certain types of chemicals. Different compounds pass through the column at different speeds, depending on their affinity to the packing or coating a detector at the exit of the column quantifies the concentration of the chemical.

- **Atomic Absorption Spectrometer (AAS):** AAS is used to analyze the presence of metals. Samples are heated either in a flame or electrically in a graphite furnace, and the absorption of light at a particular wavelength.

6.4. Purpose of Selecting Test Methods

Selecting a test method depends on the purpose of the test and how the results are going to be used. There is no single test to determine the quality of water.

Deciding on an appropriate method for testing is based on the following considerations:

- The range of concentrations of the contaminants that need to be determined.
- The accuracy and precision required
- The maximum time period between sampling and analysis
- Technical skills required
- Cost of equipment and materials for each test

6.5. Common Physical testing parameters

The physical characteristics of drinking water are usually things that we can measure with our own senses: turbidity, color, taste, odor and temperature. In general, we judge drinking water to have good physical qualities if it is clear, tastes good, has no smell and is cool.

- **Color:** The color of water is due to dissolved or colloidal materials like iron, manganese , clay, silt……
- **Taste/odor**: Taste/odor of water is typically treated by aeration. Aeration is a process of releasing dissolved gases from raw water by exposing to the air.

- **Turbidity:** Turbidity is a property that is a result of particles of solid matter being suspended in water, rather than dissolved into it. If water is turbid it appears to be cloudy, so is a visual guide to water quality.
- Turbidity of water can be tested in the laboratory using a device of turbidity meter. The result of turbidity of as sample is described in a unit of NTU (Nephlometric Turbidity Unit). The WHO Guideline for turbidity in drinking water is less than 5 NTU.

Fig.6.2 Turbidity meter

Turbidity tubes:

Turbidity tubes are another easy and cheap way to visually estimate the turbidity of water.

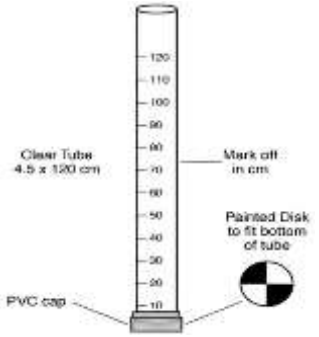


Fig.6.3. Turbidity tube

- **Temperature:** Is a physical property of water showing how the water is hot or cold. The temperature of water can be measured using an instrument called thermometer. Thermometer can be found in the market in different designs and marks.

6.6. Common Chemical Parameters for Testing

Some of the most common chemical parameters for testing includes:

- **p^H**: is a way of expressing the hydrogen-ion concentration of a solution. It is a measure of how acidic or alkaline the water is on a scale 0 to 14. Pure distilled water is neutral with a pH value of 7.
- p^H measurement below 7 indicates the solution is acidic containing more H^+ ions than OH^- ions. Measurement of pH 7above indicates that the reverse situation exists making the water alkaline. P^H meter is a device used to measure the p^H values of a sample of water.
- **Total Dissolved Solids (TDS):** Total dissolved solids (TDS) contained in water are made up of inorganic salts (mainly sodiumchloride, calcium, magnesium, and potassium) and small amounts of organic matter that are dissolved in water.

Total dissolved solids of a sample of water can be measured in the laboratory using a device of **TDS** meter.

- **Electrical Conductivity (EC):** Electrical conductivity (EC) of a substance is defined as its ability to conduct or transmit electricity through it. The presence of chemicals (such as calcium and magnesium ions) gives water the ability to conduct electricity.

Testing for EC does not give specific information about the types of chemicals present in water, but it gives an estimation of total dissolved solids (TDS). Thus, the EC of water is an indirect measure of dissolved chemicals.

- **Fluoride, F^-** :.Owing to the universal presence of fluorides in the earth's crust, all water contains fluorides in varying concentrations. The bulk of the water normally available to humans is involved in the hydrological cycle, which means that it originates in the sea. Traces of fluorides are present in many waters; higher concentrations are often associated with underground sources.High concentrations of fluoride in water causes dental mottling and flourosis.
- **Iron: Fe^{+2}**: Iron is found in most natural waters and can be present in several forms, namely in true solutions as collide or in a suspension as visible particles; or as a complex with other mineral or organic substances.
- **Hardness**: in water is due primarily to calcium and magnesium carbonates and bicarbonates (carbonate hardness that can be temporarily removed by heating) and calcium sulfate, calcium chloride, magnesium sulfate, and magnesium chloride (noncarbonated or permanent hardness that cannot be removed by heating). The sum of carbonate and non-carbonated hardness is total hardness, expressed as calcium carbonate.
- **Manganese:** Manganese can be naturally found in groundwater and surface water, and it usually occurs with iron. However, human activities may also be responsible for manganese contamination in water in some areas. Water with high levels of suspended manganese usually has a black color or black flakes in it.

- **Dissolved oxygen:** Dissolved oxygen (DO) is a measure of the quantity of free oxygen molecules dissolved in water. The concentration of DO is an important indicator of the health of an aquatic ecosystem because oxygen is essential for almost all forms of life. Oxygen is necessary for respiration and for some chemical reactions. Ongoing low dissolved oxygen in a water body will harm most aquatic life, because there will not be enough to sustain life. DO of water or waste water can be measured using a device of DO meter.

6.7. Biological Parameters for Testing

Biological characteristics: also called bacteriological characteristics. These include bacteria, virus, protozoa and worms. They cause waterborne_diseases. Generally, microorganisms in water are classified as coliforms. Two types of coliforms are there in water- total coliform and fecal coliforms. Total coliforms are collection of all microorganisms (both harmful and harmless). Fecal coliforms are harmful ones. They are measured in water by the method called membrane filtration.

In this method sample of water is filtered by a membrane (filter paper) with pore size 0.45µm (micrometer) and put in a dish with growth media and incubated for 14 to16 hours. For total coliform temperature of incubator is set at $37^{O}C$ and for fecal coliform at $44^{O}C$.

- **Calibration of testing equipment**

In order to determine whether a product meets the customer requirements, measurements are often performed. To ensure that these measurements are reliable, they must be traceable to the results. The only way to ensure traceable results is to use calibrated measurement instruments. It is therefore that many quality systems as the ISO/IEC 9000 series and ISO/IEC 17025 require that instruments are regularly calibrated, in other words has to be included in a calibration system.

Calibration is the process of comparing a reading on one piece of equipment or system, with another piece of equipment that has been calibrated and referenced a set of parameters.

.

Self-Check -6	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page

Part I. **Multiple Choice items:** Choose the correct answer from the alternatives given**.**

1. The concentration of residual chlorine in water can be determined using--------Test.

   A. BOD B. DPD C. DO D. EC

2. The hardness of water is due to dissolved ---------- and ----------salts.

   A**.** Calcium and magnesium B. Sodium and magnesium

   C. Calcium and iron D. Manganese and calcium

3. A solution having a p^H value of greater than 7 is termed as_____.

   A. Neutral B. Acidic C. Basic D. Concentrated

4. Selection of a test method can depend on:

   A. The purpose of the test B. How the results are going to be used

   C. The volume of the sample D. All

5. Flourosis is a skeletal disease which is caused by ----------.

   A. Manganese B. Iron C. Fluoride D. Chloride

Score = _____

Rating: _____

Note: **Satisfactory rating – 2 points Unsatisfactory - below 2 points**

Answer Sheet 6

Name: _____ Date: _____

Multiple choice items

1_____

2_____

3_____

4._____

5._____

Operation Sheet 1	Prepare for laboratory work tests

Procedures for preparing Laboratory work tests

Step 1- Wear Lab coat and other safety

Step 2- Thoroughly clean the work apparatus

Step 3- Plan your work to finish at the stipulated time

Step 4- Be economical with reagents/solutions

Step 5- Handle glass apparatus carefully

Step 6- Dispose of all waste liquids appropriately

Step 7- Keep your seat clean. Wash off any spilled chemical

Step 8- Clean and keep the apparatus used.

Step 9- Wash your hands with soap and water after experiment.

Operation Sheet 2	Perform calibration for P^H meter

Procedures for Calibration of P^H meter within 30 minutes of hour.

Task 1. Prepare a buffer solution with p^H values of 4, 7 and 10 for calibration.

Task 2. Rinse the p^H electrode first with *de-ionized* water and then in the p^H 10 buffer.

Task 3. Place the electrode into the p^H value of 10 buffer calibration beaker, so the electrode tip and junction are fully immersed in the buffer, and stir the buffer at a moderate, uniform rate

Task 4. Start the calibration on the meter and Wait for a stable reading in the p^H 10 buffer, at least 1 to 2 minutes then display its temperature-corrected p^H value.

Task 5. Once the correct buffer value is entered, prompt the meter to proceed to the next calibration point.

Task 6. Rinse the p^H electrode first with deionized water and then in the p^H 7 buffer rinse beaker.

Task 7.Place the electrode into the p^H 7.00 buffer calibration beaker, so the electrode tip and junction are fully immersed in the buffer, and stir the buffer at a moderate, uniform rate and Wait for a stable reading in the p^H 7 buffer, at least 1 to 2 minutes then display its temperature-corrected p^H value

Task 8. Once the correct buffer value is entered, prompt the meter to proceed to the next calibration point

Task 9. Rinse the p^H electrode first with deionized water and then in the p^H 4 buffer rinse beaker. Place the electrode into the p^H 4 buffer calibration beaker, so the electrode tip and junction are fully immersed in the buffer, and stir the buffer at a moderate, uniform rate and Wait for a stable reading in the p^H4 buffer, at least 1 to 2 minutes the it display its temperature-corrected p^H value

Operation Sheet -3	P^H Value Determination

Procedures for determination of P^H

Step1. Calibrate the p^H meter according to instructions supplied by the Lab staff

Step2. Pour sample into a clean beaker

Step3. Rinse the probe thoroughly with distilled water to prevent any carry-over. Switch to p^H mode

Step4. Immerse the probe in the sample

Step5. Establish equilibrium between probe and sample by stirring to insure homogeneity. Gently drop a stirring bar into the sample and place the beaker on a magnetic stirrer. Start the magnetic stirrer and adjust the speed to give thorough but gentle mixing

Step6. Read and record the p^H

Step7. Rinse the electrode thoroughly with distilled water

Step8. When not in use, the electrode should be replaced in the beaker containing water.

Operation Sheet 4	Conducting Color test with spectrometer

Procedures for determination of Color test by Spectrophotometer

Step.1. Place the cell containing the blank (distilled water) in the sample compartment with the transparent sides facing the light source. Close the sample compartment lid.(Note: Do not touch the transparent sides of the sample cell and keep it clean)

Step. 2.Press “AUTOZERO” key to set the zero absorbance

Step.3. Discard the distilled water and place the cell containing the sample in the measuring position. Close the sample compartment lid

Step.4. Press “START” key to measure color

Step.5. Record the “Conc” as color units for the sample

Step.6. Report the results as follows:

- Color Units Record to nearest

1 ~ 50 ⟶ 1

51 ~ 100 ⟶ 5

101 ~ 250 ⟶ 10

251 ~ 500 ⟶ 20

Operation Sheet 5	Test Total dissolved solid/ EC digital method

Procedures for determination of Electrical conductivity/ TDS

Step1. Rinse the sample beaker and the meter twice with the water to be sampled. (Make sure, you have removed the cap from the meter before rinsing.

Step2. Collect the sample.

Step3. Swirl the meter in the sample five times

Step4. Check the bottom of the meter to be sure there are no air bubbles trapped

Step5. If there are air bubbles, tap the bottom of the meter against the side of the beaker until the bubbles float up

Step6. Turn on the meter now and wait 1 ½ minutes and read and record the display on the meter

Step7. Be sure the meter is at least one centimeter above the bottom of the beaker during the 1-½ minutes.

Step8. Also be sure that the sample and the meter are out of direct sunlight or wind

Step9. Record the reading.

Operation Sheet 6	Conduct Turbidity test

Steps for determination of Turbidity

Step1. Select the operating range at" AUTO" mode.

Step2. Fill a clean sample cell to the mark with the test sample and place it in the cell holder. The sample cell must be clean, dry and free of fingerprints.

Step3. Wipe the outside of the cell with a lens tissue and align the dot on the sample cell with the raised mark on the spill ring around the cell holder opening.

Step4. Be sure the cell is kept down completely and held in place by the spring clip.

Step5. Cover the sample with the light s

Operation Sheet 7	Conduct Chlorine residual test

Procedures for determination of Residual Chlorine

Step1. Place one tablet in the test chamber and add a few drops of the chlorinated water supplied under test.

Step2. Crush the tablet, then fill the chamber with the chlorinated water supply under test

Step3. Place more of the same water supply under test in the second chamber

Step4. The level of chlorine residual in mg/L is determined by comparing the color of the water supply shield. The digital read out is in Nephelometric Turbidity Units (NTU).

Operation Sheet 8	Conduct jar test

Procedures for Jar Testing

Step1. Prepare a 1% alum and 1% lime solution.

Step 2. Number and fill six a 1 L beakers with the raw water sample

Step 3. Measure the turbidity and pH of the sample water

Step 4. Place the 6 beakers under the mechanical stirrer and turn on the motor. (Immediately adjust the speed to 80 rpm.

Step.5. Using pipettes, add alum stock solution to the six beakers at the following dosages: l0ml, 20 ml, 30 ml, 60 ml, 80 ml and 90 ml.(It depends on the turbidity your sample)

Step.6. Now insert the paddle of the jar testing apparatus inside the beakers.

Step7. Maintain the paddle at 80 rpm for 2 minute, then reduce to 30 rpm. Stir at this rate for 15 more minutes. Observe the jars carefully and record the time at which the first floc appears in each jar.

Step8. At the end of the slow stirring period, stop the stirrer. Record the floc in a table for each sample

Step 9.Allow the beaker to settle down for 20 minutes.

Step 10 .Make an observation as of which of the 6 beakers is most clearer than others.

Step 11..Also measure the turbidity of each beaker using a turbidity meter and tabulate your results.

Step12. Clean up the tools and apparatus

Step 13.Calculate the mass of chemicals required for your purpose depend on your lab result.

LAP Test 1	Practical Demonstration

Name: _____ **Date:** _____

Time started: _____ **Time finished:** _____

Instructions: Given necessary reagents, tools and materials you are required to perform the following tasks within 5 hours

TASK.1. Conduct Residual chlorine test using DPD test method.

TASK 2. Conduct for P^H value testing

TASK 3. Conduct for TDS/EC testing

TASK 4. Conduct for turbidity of a sample

TASK5. Conduct jars test analysis using raw water from surface source.

Instruction Sheet-3	Learning Guide 19 Conduct Basic water and waste water Tests

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Locating and Identifying correct samples for testing and reporting abnormal sample characteristics
- Conducting basic waste water tests.
- Maintaining Integrity of samples during testing.
- Identifying atypical data and taking appropriate action

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Locate and identify correct samples for testing and report abnormal sample characteristics*.*
- Conduct Basic wastewater tests
- Maintaining Integrity of samples maintained during testing.
- Identify Atypical data and take appropriate action

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 5”. on pages 68,71,74 and 77.Try to understand what are being discussed.
4. Accomplish the “Self-checks 1,2,3,4 & 5” in each information sheets on pages 70,73,76 79.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1 & 2 on pages 82 and 83. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After you accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; Then proceed to the next LG.___.

Information Sheet-1	Identifying and Locating Correct Samples for Testing

1.1. Introduction to waste water and abnormal sample characteristics

Wastewater: is simply that part of the water supply to the community or to the industry which has been used for different purposes and has been mixed with solids either suspended or dissolved.

Wastewater contains pathogenic microorganisms lead to dangerous diseases to humans and animals' hazardous matter such as heavy metals that are toxic produces odorous gases and bad smell. Wastewater is composed of 99.9% water and 0.1% solids.

Fig1.1. Waste water source

1.2. Types of waste Water

- **Gray water:** Washing water from the kitchen, bathroom, laundry (without faeces and urine).
- **Black water:** Water from flush toilet (faeces and urine with flush water)
- **Yellow water:** Urine from separated toilets and urinals.
- **Brown water:** Black water without urine or yellow water

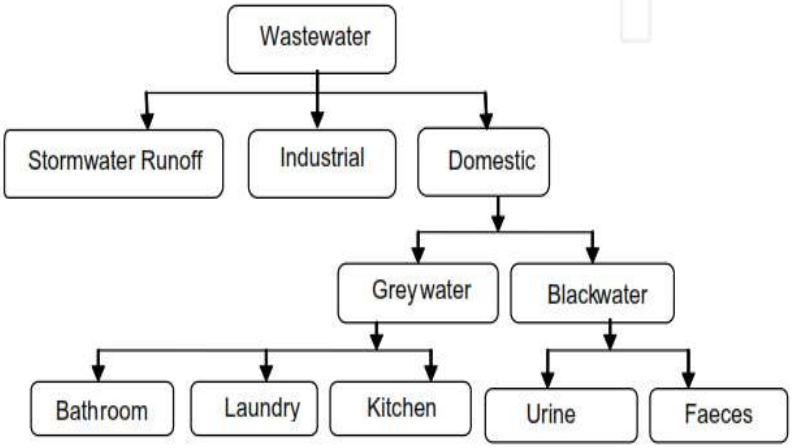


Fig.1.2. Classification of waste water

1.3 Main parameters defining waste water

The main parameters predominantly found in domestic sewage that deserves special consideration are:

- Solids
- Indicators of organic matter
- Nitrogen
- phosphorus
- Indicator of feacal contamination.

1.4. Abnormal characteristics of water/waste water

Waste Samples which are not taken correctly may have the following characteristics.

- **Insufficient volume**: at least one liter of sample should be taken.
- **Odor**: water with bad odor may be characterized as an abnormal sample.
- **Visible contaminants** such as scum, debris, etc
- **Scum:** Is a layer of bubbles of unpleasant substance that forms on the surface of a liquid.
- **Debris**: Pieces of materials that are left in sample containers which can further affect the quality test sample water.
- **Discoloration**: Is a process of becoming discolored.

Self-Check -1	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page

Part I. **True or False items**

1. Black water is type of waste water from flush toilet (faeces and urine with flush water)
2. Yellow water is water without urine and feaces.
3. Scum, debris are among abnormal characteristics of a sample.
4. Indicator of fecal contamination is a parameter predominantly found in domestic sewage
5. Waste water predominantly composed of organic and inorganic mater**.**

Note: **Satisfactory rating – 2 points Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ **Date:** _____

Score = _____

Rating: _____

TRUE OR FALSE ITEMS

1_____

2_____

3_____

4._____

5._____

Information Sheet-2	Conducting Basic waste Water testing

2.1. Introduction to water testing

A. Physical Characteristics of waste water

- **Solids:** Solids are classified into three main types:
  - ✓ **Total Solids** (TS): All the matter that remains as residue upon evaporation at 103 ºC to 105 ºC
  - ✓ **Settleable solids:** Settleable solids are measured as mg/L, which is an approximate measure of the sludge that can be removed by primary sedimentation.
  - ✓ **Suspended solids** (SS) and Filterable solids (FS)
- **Odour:** Odor is produced by gas production due to the decomposition of organic matter or by substances added to the wastewater.
  - ✓ **Detection of odor**: Odor is measured by special instruments such as the portable H_2S meter which is used for measuring the concentration of hydrogen sulfide.

- **Temperature:** Temperature of wastewater is commonly higher than that of water supply. Depending on the geographic location the mean annual temperature varies in the range of 10 to 21ºC with an average of 16ºC.
- **Density:** Almost the same density of water when the wastewater doesn't include significant amount of industrial waste.
- **Color:** Fresh waste water light brownish gray, with time dark in colour and sometimes pink due to algae or due to industrial colours.
- **Turbidity:** It is a measure of the light- transmitting properties of water.

B. Chemical characteristics of wastewater

Points of concern regarding the chemical characteristics of wastewater are Organic matter, inorganic matter, Gases and p^{H}.

- **Measurements of organic matter**
  - ✓ **Biochemical oxygen demand (BOD):** It measures the strength of the waste water measuring the amount of dissolved oxygen used by microorganisms during the biochemical oxidation of organic matter in 5 days at 20ºC

- ✓ **Chemical oxygen demand (COD**): It is the total measurement of all chemicals in the water that can be oxidized. It is determined by measuring the dissolved oxygen used during the chemical oxidation of organic matter in 3 hours.

Self-Check -2	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page

Part I. **True or False items**

1. BOD measures the strength of the waste water.
2. COD measures of all chemicals in waste water that can be oxidized.
3. Temperature of wastewater is commonly lower than that of water supply.
4. Fresh waste water usually pink in color.
5. Total solids is an approximate measure of the sludge that can be removed by primary sedimentation.

Note: **Satisfactory rating – 2 points** **Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers

Answer Sheet

Name: _____ **Date:** _____

Score = _____

Rating: _____

TRUE OR FALSE ITEMS

1_____

2_____

3_____

4._____

5._____

Information Sheet-3	Maintaining the integrity of Samples

3.1. Introduction to marinating integrity of sampling

To ensure that sampling is consistent, and of good quality and traceability, samples need to be representative of the body from which they were taken. If the sample integrity is altered, the information gained from analysis could be misleading and ultimately result in mismanagement of water resources and/or polluting of the resource.

The main processes that have the potential to affect the integrity of a sample are listed below. These processes are interlinked and a change in one thing may have a flow-on effect that will influence another, eg a change in temperature can cause chemical changes.

- **Contamination**

  Contamination of a sample occurs when foreign substances are introduced into it. This will lead to the sample having characteristics that are not representative of the in-situ conditions.

  Contamination of a sample can occur at any stage of the sampling process from the collection of samples through to the final analysis, and will have a direct effect on the integrity of the sample. As many results are reported in fractions of grams, even extremely small volumes of contaminants can significantly affect results. Contamination can be very costly, especially if decisions are based on unrepresentative data

- **Physical changes**

  Any process that changes the physical nature of a sample may affect the integrity of that sample. Temperature of water varies throughout the day and year. A change in temperature can alter the chemical properties of a wide range of many parameters.

- **Chemical changes**

  Precipitation is the formation of solids from dissolved constituents. It can be caused by a change in conditions, such as temperature, pH, chemical concentration, or the presence of seed particles to begin the process. For example, where a groundwater sample experiences loss of carbon dioxide a rapid change in pH can occur, causing precipitation of metals such as iron.

  Oxidation is caused by the introduction of oxygen (in air) to the sample. Oxidation results in increased dissolved oxygen, pH and redox. These changes can lead to decreases in

concentrations of calcium ions, magnesium ions, heavy metals (particularly iron and manganese), hydrogen supplied and ammonium.

- **Biological processes**

Biological activity in a sample may affect both its physical and chemical characteristics.

Parameters such as nitrite and nitrate can be affected by bacterial activity, i.e. denitrification. Biological activity may change the amount of dissolved oxygen, the pH and/or redox. Factors influencing the biological activity of a sample may in turn be influenced by temperature, available oxygen, pH and exposure to UV light.

The collection, equipment and preservation methods used for sampling should be chosen to minimize the impacts of the above-mentioned factors. To minimize and to quantify the impact of these processes on sample integrity, quality control protocols and procedures must be developed and implemented at all stages of monitoring.

Self-Check -3	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page

Part I. **True or False items**

1. Oxidation is caused by the introduction of oxygen (in air) to the sample.
2. Physical change is any process that changes the physical nature of a sample may affect the integrity of that sample.
3. Biological activity in a sample may only affect the chemical characteristics.
4. Oxidation could lower the concentrations of bulk organic parameters, chemical oxygen demand (COD), biological oxygen demand (BOD) and TOC of a sample.

Information Sheet-4	Identifying a typical data

4.1. Introduction to data

During water sample testing results of samples are to be determined using appropriate tools, reagents and equipment. The analysis laboratory results of water samples may or may not be found at the recommended range of legislatives and organizational requirements. Some results of samples may fall outside legislative and organizational range requirement.

For example, if the turbidity test result of a given sample of water is obtained greater than 5 NTU, this result is beyond the required WHO and Ethiopian water quality guide line requirement. So, this result shows there is a result deviation that invites a proper action to be taken to improve the turbidity of that sample of water. Because the Who and Ethiopian drinking water turbidity recommends the of turbidity of water used for drinking should be less than 5 NTU.

Reports should be made as early as possible to the concerned body so that corrective actions can be taken to ensure safe drinking water. It is also important to share the results with the users and/or community so that they are aware of their drinking water quality and understand if corrective actions need to be taken.

- **Organizational Range Requirements**
  - ✓ **Drinking Water Quality Standards**

Drinking water standards have been set by a number of countries and international organizations. The number of standards published by these organizations and the frequency of their revision is increasing.

The World Health Organization (WHO) is a specialized agency of the United Nations with primary responsibility for international health matters and public health. In carrying out that responsibility, it assembles from time to time international experts in the field of drinking water to establish Guidelines for Drinking water Quality (WHO, 1996). The primary aim of this publication is the protection of public health.

The Federal Democratic Republic of Ethiopia Ministry of Water Resources has developed a tailor-made national water quality guideline in the basis of latest publications of WHO Guidelines for Drinking water quality volumes- 1,2,3 and addendum of volume-1 and taking into consideration a variety of local factors.

Here below is a table which indicates the WHO and Ethiopian water quality guide line values of some parameters of water.

Table 1. Basic Physico Chemical drinking Water Quality Standards

Parameter	WHO Guide Line	Ethiopian Guide Line
pH value	6.5 to 8.5	6.5 to 8.5
Total Dissolved Solids (mg/l)	1000	1776
Total Hardness as $CaCO_3$, (mg/l)	500	392
Total Alkalinity (as $CaCO_3$)	200	200
Chloride (mg/l)	250	533
Fluoride (mg/l)	1.5	3
Free Residual Chlorine, mg/lt	0.2-0.5 at distribution point	0.1-0.2
Turbidity, NTU	Less than 5	Less than 5
Nitrate, mg/lt	10	40
E. Coli, MPN/100 ml	0	0
Total Coliform bacteria, MPN/100ml	0	0

Self-Check -4	Written Test

Directions: Answer all the questions listed below. Use the Answer sheet provided in the next page

Part I. **True or False items**

1. **UNICEF** is a specialized agency of the United Nations with primary responsibility for international health matters and public health.
2. The recommended p^H value of a sample of water according to WHO and Ethiopian water quality guidelines is in the range of 6.5 to 8.5.
3. If water quality testing results are found not satisfying the requirements, corrective actions should be taken to ensure safe drinking water.
4. Each country may have developed its own water quality guideline considering the context of that country.
5. **WHO** Guide line values represent the concentration of a constituent that does not result in any significant risk to health over a lifetime of consumption?

Answer Sheet

Name: _____ **Date:** _____

Score = _____

Rating: _____

TRUE OR FALSE ITEMS

1_____

2_____

3_____

4._____

5._____

Operation Sheet -1	Waste Water P^H Value Determination

Procedures for determination of P^H value

STEP.1. Calibrate the p^H meter according to instructions supplied by the Lab staff

STEP2. Pour sample into a clean beaker

STEP3. Rinse the probe thoroughly with distilled water to prevent any carry-over. Switch to p^H mode

STEP4. Immerse the probe in the sample

STEP 5. Establish equilibrium between probe and sample by stirring to insure homogeneity. Gently drop a stirring bar into the sample and place the beaker on a magnetic stirrer.

STEP 6. Start the magnetic stirrer and adjust the speed to give thorough but gentle mixing

STEP 7. Read and record the p^H

STEP8. Rinse the electrode thoroughly with distilled water

STEP9. When not in use, the electrode should be replaced in the beaker containing water.

Operation Sheet -2	Determination of Total suspended Solids(TSS)

Operating Procedures for TSS determination

Step1. Press STORED PROGRAMS.

Step2. Select the test.

Step3. Blend 500 ml of sample in a blender at high speed for exactly two minutes.

Step4. Pour the blended sample into a 600-mL beaker. prepared Sample:

Step5. Stir the sample and immediately pour 10 ml of the blended sample into a sample cell.

Step6. Blank Preparation: Fill a second sample cell with 10 ml of tap water or deionized water.

Step7.Remove gas bubbles in the water by swirling or tapping the bottom of the cell on a table.

Step8. Insert the blank into the cell holder with the fill line facing right

Step.9. Press ZERO. The display will show: 0 mg/L TSS

Step 10. Swirl the prepared sample to remove any gas bubbles and uniformly suspend any residue.

Step11.Insert the prepared sample into the cell holder with the fill line facing right.

Step12. Press READ. Results are in mg/L TSS.

LAP Test 1	Practical Demonstration

Name: _____ **Date:** _____

Time started: _____ **Time finished:** _____

Instructions: Given necessary reagents, tools and materials you are required to perform the following tasks within 1 hour.

task1. Apply proper PPEs

task2.Determine pH values of a waste water sample

task3. Determine the TSS of waste water sample

task4. Record results

task5.Prepare documents

Instruction Sheet-4	Learning Guide #20 Finalize Work.

This learning guide is developed to provide you the necessary information regarding the following **content coverage** and topics:

- Making of Records
- Recording relevant information
- Reporting observations or measurements that are outside established organizational guidelines for further action.
- Disposing of samples and cleaning and storing test equipment.
- Clearing and restoring Work area

This guide will also assist you to attain the learning outcome stated in the cover page. Specifically, **upon completion of this Learning Guide, you will be able to**:

- Make Records according to assignment requirements.
- Report observations or measurements that are outside established organizational guidelines for further action.
- Dispose of samples and cleaning and storing test equipment
- . Clean and restore Work area.

Learning Instructions:

1. Read the specific objectives of this Learning Guide.
2. Follow the instructions described below
3. Read the information written in the “Information Sheets 1- 5”. Try to understand what are being discussed. Ask you teacher for assistance if you have hard time understanding them.
4. Accomplish the “Self-checks 1,2,3,4 & 5” in each information sheets on pages 87, 90, 92, 95 and 97.
5. Ask from your teacher the key to correction (key answers) or you can request your teacher to correct your work. (You are to get the key answer only after you finished answering the Self-checks).
6. If you earned a satisfactory evaluation proceed to “Operation sheets 1 on pages 97 and do the LAP Test on page 99”. However, if your rating is unsatisfactory, see your teacher for further instructions or go back to Learning Activity.
7. After You accomplish Operation sheets and LAP Tests, ensure you have a formative assessment and get a satisfactory result; Then proceed to the next LG.

Information Sheet-1	Making Records

1.1. Introduction recording

In the method of water and waste water sample collection, sample labeling, sample transportation and sample testing, various activities are carrying out. Once the prepared and collected samples are arrived to the concerned laboratory, satisfactory preparation should be taken place. Conducting of sample test will be performed using appropriate tools, equipment, correct reagents, and other chemicals. In such processes, applying of laboratory safety procedures and using of appropriate personal protective equipment's is important and compulsory in order not to expose to work place injuries and hazards.

Recording of all relevant information as well as determining and reporting of accurate and relevant results from testing are to be carried out. In some cases, in addition to test results a lab may make notes on any contaminants that exceed international or national drinking water standards.

1.2. Making of Sample records sample

In the process of water and waste water sampling and testing activities, records have to make accurately. In the way of record making activities the following points should be taken in to consideration**:**

- Sample records such as field detail sheets or chain of custody forms including information of:
  - ✓ time sample taken

- ✓ details of person collecting sample
- ✓ sample point
- ✓ Volume of sample collected according the type and nature of test.
- ✓ data gathered at time of collection
- ✓ pre-treatment which has been carried out
- ✓ preservation methods
- ✓ instructions to sample transporters

Self-Check -1	Written Test

Direction I: Choose the best answer for the following questions. Use the Answer sheet provided in the next page: Each question worth one point

WRITE TRUE or FALSE

1. During transportation of samples it requires proper preservation.
2. In recording of sample information, no need of indicating details of person collecting sample.
3. Sample location is the place in which testing of sample to be carried out.
4. Sample records are registered in field sheet and data sheet formats.

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Multiple choice items

1_____

2_____

3_____

Information Sheet-2	Recording relevant information

2.1. Introduction to relevant information

Laboratory records are the set of documentation that constitute of written statements of overall intentions and directions as defined or given by the organization. Laboratory records contain the entire information from the stage of receiving a raw sample to knowing of the test result.

Reports communicate information which has been compiled as a result of study and analysis data and of issue. Good reports are documents that are accurate, objective and complete.

Once the lab has completed testing the water sample, a report will be prepared which contain a list of contaminants tested, the concentrations, and in some cases, highlight any problem.

2.2. Recording Information of sampling and testing results

Water and waste water testing results have to consist of records containing relevant information of the work process and organizational requirement.

- time and logging of sample receipt and testing
- visual observations
- equipment identification
- atypical results
- test results

Table 1.1.Analytical result report

AFMAC WATER ANALYSIS REPORT Ref No.....025497

ORGANISATION: FOUNDATION FOR AFRICA

LOCATION: MAZYOPA COMMUNITY SCHOOL

SOURCE TYPE / SAMPLE DISCRIPTION: BOREHOLE WITH HAND PUMP & TANK

DATE SAMPLED: 2012-11-14 DATE TESTED: 2012-11-14 &15

PARAMETER	UNIT	Hand pump Mark 11	Water Tank Via Tap	Zambian Standard (Maximum Permissible Limit)	WHO Guidelines
E.coli	CFU/100 ml	102*	138*	0	0
pH		7.13	7.20	6.5-8.0	
Turbidity	NTU	2.14	1.32	10	<5
Iron	mg/l	0.07	0.09	1.0	0.3
Phosphate	mg/l	0.98	0.70		
Fluoride	mg/l	0.20	0.01	1.5	1.5
Nitrate	mg/l	19.8	21.2	10	50
Nitrite	mg/l	0.23	0.25	1.0	3
HardnessCaCO3	mg/l	198	130	500	
Manganese	mg/l	0.005	0.005	0.1	0.5
Chloride	mg/l	75	75	600	
Copper	mg/l	1.55	1.55	1.0	2.0

*outside Limit/Guideline

COMMENT : The quality of the water indicates feacal contamination .Chlorination of the borehole is recommended after which repeat sampling and testing should be conducted. Household water treatment is recommended .

E. BANDA_____DATE...2012-11-15
Lab Manager

Cc Director SHIP Zambia
Program Manager AFMAC
File #

Self-Check -2	Written Test

Direction I: Choose the best answer for the following questions. Use the answer sheet provided in the next page: Each question worth one point

1. Laboratory records contain the entire information from the stage of receiving a raw sample to knowing of the test result.
2. Reports communicate information which has been compiled as a result of study and analysis.
3. An important feature of a report is the units used to measure the contaminant level in the water

Note: **Satisfactory rating – 3 points** **Unsatisfactory - below 3 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Multiple choice items

1_____

2_____

3_____

Information Sheet-3	Reporting observations or measurements that are outside standards for further action

3.1. Introduction to reporting information

When sampling is performed sometimes unusual or abnormal conditions may happen these conditions should be reported to the appropriate person.

Reporting of result of samples inadequate quality but that still were tested.

- Report test result which show deviations/variation from the standard requirement for further correction.
- Report of unusual or unexpected events which have the potential to impact on product quality, system integrity or personal safety to the authorized personnel.
- Report observations or measurements that are outside standard requirements.

3.2. Data Handling and Reporting

Verified analytical results are normally entered in to a laboratory data management system of some type. The system should contain the sampling data, including:

- Time and exact location,
- Analysis date and times,
- Names of analysts,
- Analytical methods/techniques used, and
- Analytical results.

Self-Check -3	Written Test

Direction I: Choose the best answer for the following questions. Use the Answer sheet provided in the next page: Each question worth one point

TRUE OR FALSE ITEMS

1. When abnormal conditions are happened in work area reporting to the appropriate person is advisable.
2. Analytical methods or techniques used in the testing process should be identified.
3. Test result which show deviations from the standard requirement should not be included in reporting.

Note: **Satisfactory rating – 2 points** **Unsatisfactory - below 2 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

True or False items

1_____

2_____

3_____

Information Sheet-4	Disposing of samples and cleaning and storing of test equipment

4.1. Introduction disposing of sample

Prior to the disposal or transfer of waste to a waste carrier, laboratories must identify the type and nature of the waste to be disposed whether it is hazardous to animals, plants as well as to the environment.

Acidic wastes should be stored separately from basic wastes, oxidizers should be stored separately from organics, and cyanide positive wastes should be stored separately from acids to reduce the possibility of inadvertent potentially dangerous releases/exposures, fires, or increased hazardous status.

4.2. Disposal of Sample

Laboratory waste should be handled safely, otherwise can cause harm to human and the environments. Since sample and used reagents can pollute the environment, should be disposed in well prepared and protected areas.

- Avoid discharge to the surrounding area. Always wash your hands thoroughly with soap after handling the contaminated waste and before touching clean and sterilized equipment.
- If possible, you should wear disposable gloves
- Dispose chemical test safely and properly.
- Wash contaminated sample containers (e.g., sample bottles, test tubes), before they can be reused.
- Clean sample containers for physical and chemical tests.
- Flushed out down chemical waste to the toilet or sink with plenty of water.
- Burn solid waste, such as test strips, dispose and/or in the garbage.
- Dispose of waste materials in line with organisational and environmental safe procedures.
- After completing your test, apparatus must be properly cleaned and ready for next use. Though washing with water can serve this purpose, rinsing with concentrated Hydrochloric (HCL) or Nitric (HNO_3) acid may be necessary if the glasses are greasy. It is then washed with water
- The effective cleaning of sampling equipment prevents, minimizes and limits the cross-contamination of samples taken during a sampling trip or between sampling trips.

- Cleaning is also used to remove manufacturing residues from new equipment and to remove dust and any other foreign substances from equipment that has been in long-term storage.
- Laboratory testing equipment should be cleaned after testing and be stored in the right shelf or container according to laboratory storing tools and equipment.
- Materials and equipment for use at some time in the future and retained either in secure, enclosed containment or unenclosed with a work area or storage facility.
- Resources could be identified, stored, protected and evaluated for further use.

Self-Check -4	Written Test

Direction I: Choose the best answer for the following questions. Use the Answer sheet provided in the next page: Each question worth one point

TRUE or FALSE ITEMS

1. Effective cleaning of sampling equipment prevents, minimizes and limits the cross-contamination of samples.
2. Disposing is used to remove manufacturing residues from an equipment.
3. Liquid chemical waste can be flushed down the toilet or sink with plenty of water.
4. Acidic wastes should be stored together with basic wastes.
5. Chemical test samples must be disposed of safely and properly

Note: **Satisfactory rating – 5 points** **Unsatisfactory - below 5 points**

You can ask you teacher for the copy of the correct answers.

Answer Sheet

Name: _____ Date: _____

Multiple choice items

1._____
2. _____
3. _____
4._____
5._____

Information Sheet-5	Clearing and restoring Work area

5.1. Introduction to clearing and restoring work area

Work area clearing is the process of removing rubble, debris and, in some cases, other materials which have been deposited due to an incident or event making an area unsafe or unusable. The ultimate aim of work site clearing is to return of the site or area to its former condition or use prior to the incident.

After the completion laboratory testing, care should be taken in clearing and restoring the work area:

- Wastes should be disposed properly according to safety legislations.
- Used tools and equipment should be collected and cleaned properly according to organizational cleaning procedures
- Clear tools and equipment from work area.
- Place reagents and chemicals to their appropriate location.
- Locking storage cabinets and restricting access to storage areas will prevent unauthorized handling of stored items and minimize the possibility of theft
- Store reusable materials and equipment in an appropriate location.
- Restore the work areas to a safe condition in accordance with agreed requirements and schedules
- Deal promptly and effectively with problems within your control and report those that cannot be solved
- Work safely at all times, complying with health and safety and other relevant organizational procedures.

Self-Check -5	Written Test

Direction I: Choose the best answer for the following questions. Use the Answer sheet provided in the next page: Each question worth one point

TRUE or FALSE ITEMS

1. Restore the work areas to a safe condition in accordance with agreed requirements and schedules

2. Deal promptly and effectively with problems within your control and report those that cannot be solved.

3. Destroying tools and equipment after completing your task.

4. Wastes should be disposed properly according to safety legislations

Operation Sheet -1	Cleaning of Test equipment

Procedures for Disposing and Cleaning of test equipment

Step 1: Select and wear appropriate PPE

Step 2: Select appropriate tools and equipment

Step 3: Prepare proper cleaning agents (Water, detergents and appropriate acids)

Step 4. Remove debris and scrums from tools and equipment

Step 5. Wash and clean the tools, lab wares and test equipment appropriately

Step 6: Dry the cleaned tools, lab wares and testing equipment

Step 7. Restore tools and testing equipment to their appropriate locations

Step 7: Clear work area

LAP Test 1	Practical Demonstration

Name: _____ **Date:** _____

Time started: _____ **Time finished:** _____

Instructions: Given necessary reagents, tools and materials you are required to perform the following tasks within 1 hour.

TASK1. **Clean testing equipment**

List of Reference Materials

1. Standard Methods for the Examination of Water and Waste Water, 21st Edition,
2. Standard Operating Procedure for Collecting Surface Water Quality Samples for the Parlee Beach Watershed Monitoring Assessment, July 2017, Department of Environment and Local Government,
3. Code of Practice on Drinking Water Sampling and Safety Plans, April 2019. WWW.Sfa.Org.sg
4. American Public Health Association, American Water Works Association, Water Environment Federation (1999)
5. INHORN, S.L., ed. 1978. Quality Assurance Practices for Health Laboratories. American
6. Public Health Assoc., Washington, D.C.
7. AMERICAN ASSOCIATION FOR LABORATORY ACCREDITATION. 1996. General
8. Requirements for Accreditation. A2LA, American Assoc. Laboratory Accreditation, Gaithersburg, Md.
9. EPA Guidelines: Regulatory monitoring and testing Water and wastewater sampling.2007, Website: www.epa.sa.gov.au
10. Introduction to Drinking Water Quality Testing. Center for affordable water and sanitation technology., Website: www.cawst.org.

.