# Wastewater Operator Certification Training
# Instructor Guide

# Module 12:
# Laboratory Overview

This course includes content developed by the Pennsylvania Department of Environmental Protection (Pa. DEP) in cooperation with the following contractors, subcontractors, or grantees:

The Pennsylvania State Association of Township Supervisors (PSATS)
Gannett Fleming, Inc.
Dering Consulting Group
Penn State Harrisburg Environmental Training Center

# A Note to the Instructor

Dear Instructor:

The primary purpose of this course, *Laboratory Overview* is to provide the participants with an overview of basic laboratory equipment and methodology to which they may be exposed. This module has been designed to be completed in approximately 3 ½ hours, but the actual course length will depend upon content and/or delivery modifications and results of course dry runs performed by the Pa. DEP approved sponsor. The number of contact hours of credit assigned to this course is based upon the contact hours approved under the Pa. DEP course approval process. To help you prepare a personal lesson plan, timeframes have been included in the instructor guide at the Unit level and at the Roman numeral level of the topical outline. You may adjust these timeframes as necessary to match course content and delivery modifications made by the sponsor. Please make sure that all teaching points are covered and that the course is delivered as approved by Pa. DEP.

Web site URLs and other references are subject to change, and it is the training sponsor's responsibility to keep such references up to date.

Delivery methods to be used for this course include:

- Lecture
- Discussion Questions
- Exercises

To present this module, you will need the following materials:

- One workbook per participant
- Extra pencils
- Flip Chart
- Markers
- Laptop (loaded with PowerPoint) and an LCD projector **or** overheads of presentation and an overhead projector
- Screen

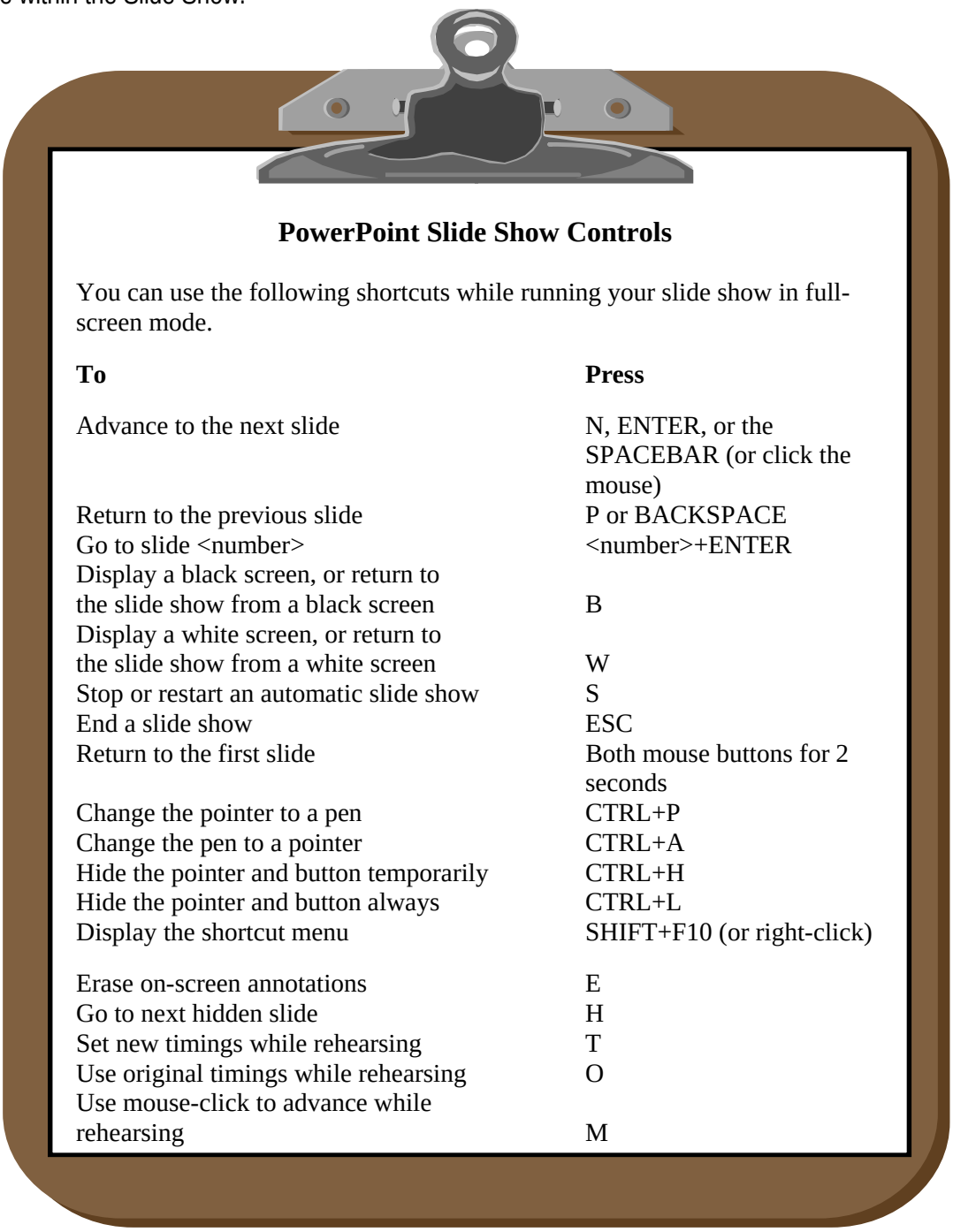
Icons to become familiar with include:

| Participant Workbook | | Instructor Guide | |
|---|---|---|---|
|  | Exercise/Activity | Same icons for Participant Workbook apply to the Instructor Guide. | |
|  | Case Study | Ans: | Answer to exercise, case study, discussion, question, etc. |
|  | Discussion Question |  | PowerPoint Slide |
|  | Calculation(s) |  | Overhead |
|  | Exercise |  | Flip Chart |
|  | Key Definition(s) |  | Suggested "Script" |
|  | Key Point(s) | | |

Instructor text that is meant to be general instructions for the instructor are designated by being written in script font and enclosed in brackets. For example:

[*Ask participants if they have any questions on how to read the table. Answer any questions participants may have about how to read the table.*]

If your module includes the use of a PowerPoint presentation, below are some helpful controls that you may use within the Slide Show.



**PowerPoint Slide Show Controls**

You can use the following shortcuts while running your slide show in full-screen mode.

| **To** | **Press** |
|---|---|
| Advance to the next slide | N, ENTER, or the SPACEBAR (or click the mouse) |
| Return to the previous slide | P or BACKSPACE |
| Go to slide <number> | <number>+ENTER |
| Display a black screen, or return to the slide show from a black screen | B |
| Display a white screen, or return to the slide show from a white screen | W |
| Stop or restart an automatic slide show | S |
| End a slide show | ESC |
| Return to the first slide | Both mouse buttons for 2 seconds |
| Change the pointer to a pen | CTRL+P |
| Change the pen to a pointer | CTRL+A |
| Hide the pointer and button temporarily | CTRL+H |
| Hide the pointer and button always | CTRL+L |
| Display the shortcut menu | SHIFT+F10 (or right-click) |
| Erase on-screen annotations | E |
| Go to next hidden slide | H |
| Set new timings while rehearsing | T |
| Use original timings while rehearsing | O |
| Use mouse-click to advance while rehearsing | M |

INTRODUCTION OF MODULE: 5 minutes

Display Slide 1—Module12: Laboratory Overview.

*[Welcome participants to "Module 12 – Laboratory Overview." Indicate the primary purpose of this course is to provide the participant with an overview of a water treatment plant laboratory including: common equipment and techniques, safety concerns, laboratory procedures, quality control and the handling of data.]*

*[Introduce yourself.]*

*[Provide a brief overview of the module.]*

This module contains 6 units. On page i, you will see the topical outline for Unit 1 – Laboratory Equipment, Terms, and Techniques and Unit 2 – Chemical Hygiene and Lab Safety.

*[Briefly review outline.]*

On this page, you will see the topical outline for Unit 3 – Sampling and Unit 4 – Laboratory Procedures.

*[Continue to briefly review outline.]*

On page iii, you will find the remainder of the outline for Unit 4 as well as the topical outline for Unit 5 –Laboratory Quality Assurance and Quality Control.

*[Continue to briefly review outline.]*

On page iv, you will see the topical outline for the final unit, Unit 6 – Data Handling, Records, and Reporting.

*[Continue to briefly review outline.]*

UNIT 1: 60 minutes

Display Slide 2—Unit 1: Laboratory Equipment, Terms and Techniques.

At the end of this unit, you should be able to:

- List the various types of glassware used in a laboratory and explain the use of each.
- List the various types of preparatory equipment and explain the use of each.
- List the various types of analytical equipment and explain the use of each.

Display Slide 3—Unit 1: Laboratory Equipment, Terms and Techniques.

The remaining learning objectives for this unit are:

- List and define the pertinent chemical, biological and analytical terms.
- List six sample preparation techniques and explain the importance of each.
- List five common sample analysis techniques and explain the importance of each.

LABORATORY EQUIPMENT: 25 minutes

Glassware

If you have ever been in a laboratory, you will have noticed there is an extensive amount of glassware present. Since each type of glassware has a very specific use, it is important that you become familiar with the common types of glassware found in the laboratory and what they are used for.

Beaker

Display Slide 4—Beakers.

As you can see from this slide, beakers come in an assortment of sizes or volumes.

*[Review information in the workbook on beakers.]*

Graduated Cylinder

Display Slide 5—Graduated Cylinders.

Like the beakers we just discussed, graduated cylinders also come in an assortment of volumes.

*[Review information in the workbook on graduated cylinders, being sure to point out the difference between "To Contain" and "To Deliver" cylinders.]*

Pipet

Like beakers and graduated cylinders, pipets are available in different volumes and they are used to measure liquids. Pipets are different however because they are smaller than beakers and graduated cylinders.

*[Review information in the workbook on pipets.]*

Buret

Display Slide 6—Burets.

As you can see from this slide, burets can vary as well. Regardless of the size of the buret, its purpose is still the same—to accurately deliver a volume of solution.

*[Review information in the workbook on burets. Point out the stopcock on the slide.]*

Flask

*[Review information in the workbook on flasks. When reviewing the last bullet item:]*

Display Slide 7—Volumetric Flasks.

This slide shows you what a volumetric flask looks like.

Bottle

*[Review information in the workbook on bottles.]*

Funnel

*[Review information in the workbook on funnel. Be sure to cover the two specialty types of funnels.]*

Test Tube

*[Review information in the workbook on test tube.]*

Imhoff Cone

*[Review information in the workbook on Imhoff cone.]*

Condenser

*[Review information in the workbook on condenser.]*

Petri Dish

*[Review information in the workbook on Petri Dish.]*

Exercise

**Ans:** A pipet and volumetric flask are the most accurate ways to measure liquids when making a standard solution. Extra credit if participants said a TD (to deliver) pipet.

The types of glassware we have just reviewed only cover the most common types you will use in a laboratory. There are many more types of glassware in a laboratory; however, we will not be able to discuss all of them in this training.

Preparatory Equipment, Incubators, Miscellaneous Equipment

For the next several minutes, our discussion will focus on equipment needed to prepare a sample before it is analyzed. As with glassware, we will focus on the most common types of equipment you will encounter.

## Burner

*[Review information in the workbook on burner.]*

## Crucible

*[Review information in the workbook on crucible.]*

## Hot Plate

*[Review information in the workbook on hot plate.]*

## Oven

*[Review information in the workbook on oven.]*

## Desiccator

*[Review information in the workbook on desiccator.]*

Incubator

*[Review information in the workbook on incubator.]*

Muffle Furnace

*[Review information in the workbook on muffle furnace.]*

Refrigerator

*[Review information in the workbook on refrigerator.]*

Fume Hood

*[Review information in the workbook on fume hood.]*

Vacuum Pump

*[Review information in the workbook on vacuum pump.]*

## Analytical Equipment

Once a sample has been prepared, it is time to analyze it. There are numerous pieces of equipment used to analyze a sample in the laboratory. We will focus on a few of the most common types of analytical equipment you may use in the lab.

### pH Meter

Display Slide 8—pH Meters.

There are many different models of pH meters. This slide shows two typical pH meters.

*[Review information in the workbook on pH meters.]*

Balance

 Display Slide 9—A Balance.

 This slide shows a typical balance.

*[Review information in the workbook on balance.]*

## Spectrophotometer

Display Slide 10—A Spectrophotometer.

This slide shows a spectrophotometer.

*[Review information in the workbook on spectrophotometer.]*

The top of the spectrophotometer slides back and the sample is then placed inside. A spectrophotometer is able to test for multiple parameters.

## Thermometer

*[Review information in the workbook on thermometer.]*

## Amperometric Titrator

*[Review information in the workbook on amperometric titrator.]*

## Colorimeter

Display Slide 11—Colorimeter.

This slide shows a colorimeter. Without looking at your workbook, can anyone tell me what a colorimeter is?

*[Review information in the workbook on colorimeter.]*

Unlike spectrophotometers, which can do hundreds of different tests, a colorimeter is usually made to do only one test. For example, a colorimeter for chlorine testing is not able to test for phosphorus.

LABORATORY TERMS: 15 minutes

Now that we have an overview of the common types of equipment used in an analytical laboratory, we need to become familiar with common terms that are used in the lab.

## Chemical

At this point we are going to talk about common chemical terms and their definitions.

[*For each of the definitions listed in the workbook, ask the participants to tell you the definition of the term without consulting their workbook. If participants are unable to tell you the definition of the term or they have defined it incorrectly, review the correct definition as listed in the workbook.]*

## Biological

In addition to chemical terms, there are common biological terms used in the laboratory that you should be familiar with.

[*Review defintions in the workbook.]*

## Analytical

There are many analytical terms frequently used in the laboratory as well. You should make sure you are familiar with these terms and their meanings.

*[Review the definitions in the workbook.]*

[*Continuing reviewing the definitions in the workbook*.]

Exercise

Thinking about the definitions we just covered, look at the graduated cylinder I am holding. What is the exact volume in the cylinder?

**Ans:** *[Note to instructor: If you do not have a graduated cylinder available draw a picture of fluid level in a cylinder. Be sure to draw the picture showing a meniscus in the cylinder as well as the volume gradations on the cylinder. Make sure the students read the volume indicated at the BOTTOM of the meniscus.]*

LABORATORY TECHNIQUES: 20 minutes

Now that you have an understanding of common laboratory terms and definitions, we will focus our attention on some specific techniques used in the laboratory.

## Sample Preparation

In some cases, after a sample has been collected, it needs additional work done to it before moving on to the analysis phase.

*[Review the information in the workbook.]*

### Collection

*[Review the information in the workbook.]*

### Preservation

*[Review the information in the workbook.]*

### Concentrate

Can anyone explain to us what concentrating a sample means?

*[Review the information in the workbook.]*

There are four different concentration techniques that can be used. Who can tell me what those four techniques are?

*[Indicate that the four techniques are listed in the workbook.]*

*[When discussing the first concentrating technique, the centrifuge:]*

Display Slide 12— Centrifuge.

This slide represents a typical centrifuge.

*[Review the information in the workbook on the remaining three concentration techniques.]*

### Dilution

*[Review the information in the workbook.]*

### Extraction

*[Review the information in the workbook.]*

### Filtration

*[Review the information in the workbook.]*

## Sample Analysis

At this point, we have collected our sample and prepared it. The sample is now ready to be analyzed. We are going to discuss five common analysis techniques, which are: ion specific, gravimetric, spectrophotometric, titration and volumetric. Let's begin with ion specific. Is anyone familiar with ion specific analysis?

### Ion Specific

*[Review the information in the workbook.]*

### Gravimetric

*[Review the information in the workbook.]*

### Spectrophotometric

Is anyone familiar with spectrophotometric analysis?

*[Review the information in the workbook.]*

### Titration

*[Review the information in the workbook.]*

### Volumetric

*[Review the information in the workbook.]*

Exercise

1. An Imhoff cone would most likely be used for what type of analysis?

**Ans:** B. Sludge Volume

2. What is the purpose of a desiccator?

**Ans:** A desiccator is used to keep chemical reagents and samples dry. Typically, a sample is heated in an oven to dry it and then placed in the desiccator to cool prior to weighing or undergoing further preparation.

3. An analytical balance would be used to do what type of analysis?

**Ans:** D. Gravimetric

4. List three sample concentration techniques.

**Ans:** Centrifuge, Distillation and Digestion

[*Review Key Points*]

Now that we have completed this unit, you should have an understanding of the various types of equipment found in a laboratory. You should also feel comfortable with the common terms used in the laboratory and you should understand the variety of sample preparation and analysis techniques. In the next unit, we will discuss hygiene and safety as it relates to operating in an analytical laboratory.

UNIT 2: 30 minutes

Display Slide 13—Unit 2: Chemical Hygiene and Lab Safety.

At the end of this unit, you should be able to:

- Explain the importance of laboratory hygiene.
- Explain the importance of a chemical hygiene plan and describe its critical components.
- List two common hazards a Treatment Plant Operator may be exposed to in a laboratory and explain how to avoid them.

Display Slide 14—Unit 2: Chemical Hygiene and Lab Safety.

The remaining learning objectives for this unit are:

- List five common rules of laboratory safety.
- List three articles of personal protective equipment and explain how each prevents injuries.
- In terms of personal hygiene, list three possible routes of infection and how to avoid them.
- List six common types of laboratory accidents and explain how to prevent them.

LABORATORY HYGIENE: 2 minutes

Hygiene and safety are of the utmost importance when working in a laboratory. There are a multitude of factors at work that could result in an accident of some sort. Have any of you ever been part of a laboratory accident?

Laboratory Hygiene and Safety

*[Review the information in the workbook on laboratory hygiene and safety.]*

[*Review the defintion of laboryatory hygiene in the workbook.]*

*[Review the remaining information in the workbook.]*

CHEMICAL HYGIENE PLAN: 3 minutes

Chemical Hygiene Plan Requirements

There are many types of hazardous materials present in a lab; therefore, a plan is needed to minimize potential accidents or hazards. This is known as a chemical hygiene plan, which we will now discuss. Can anyone tell me what types of information are typically included in a chemical hygiene plan?

[*Write participant responses on a flipchart*.]

*[Review the list of items in the workbook, focusing on those that participants missed when answering the question above.]*

LABORATORY HAZARDS: 10 minutes

As mentioned earlier, there are many hazards present in a laboratory. Typically, those hazards are classified as either infectious wastes or toxic chemicals.

### Infectious Wastes

*[Review the information in the workbook on infectious wastes.]*

### Toxic Chemicals

*[Review the information in the workbook on toxic chemicals.]*

### Activity

*[Ask participants to turn to Appendix A of their workbooks.]*

A MSDS is available from the chemical manufacturer for every chemical. You should read and understand the MSDS for each chemical used in the lab.

Appendix A shows an MSDS for Aluminum Sulfate, Liquid. Take a couple of minutes to review the sample MSDS. Typically, the MSDS will tell you what type of protective clothing or equipment is needed for the chemical you are dealing with. It will also explain appropriate first aid procedures. For example, if the chemical is inhaled, the MSDS will tell you how to respond in that situation. The MSDS also contains information about the toxicology and health data specific to the chemical and it explains the proper procedures for handling spills or disposal of wastes.

LABORATORY SAFETY: 15 minutes

Up to this point, we have discussed laboratory hygiene, the chemical hygiene plan and laboratory hazards. Now we will begin discussing specific lab safety tips and techniques.

*[Review the information in the workbook*.]

*[When reviewing the last bullet point, inform students that the following memory device can be used to remember how to mix acid and water: "Do what you ought-a, add acid to wahta."]*

Personal Protective Equipment

*[Review the information in the workbook.]*

## Personal Hygiene

*[Review the information in the workbook.]*

## Accident Prevention

*[Review the information in the workbook.]*

*[Continue to review the accident prevention information in the workbook.]*

Exercise

1. List the two general types of hazards that a Wastewater Treatment Plant Operator may find himself exposed to.

**Ans:** Infectious wastes and toxic chemicals.

2. List the three most common routes that infectious agents can enter your body.

**Ans:** Cutaneous, oral ingestion and inhalation.

3. List seven common types of laboratory accidents.

**Ans:** Any seven of the following: electric shock, cuts, burns, heat, chemical, toxic fumes, chemical spills, slip and fall and fire.

*[Review Key Points*]

UNIT 3: 30 minutes

Display Slide 15—Unit 3: Sampling.

At the end of this unit, you should be able to:

- Describe the importance of sampling.
- List the common sampling techniques used in a laboratory.
- Explain the importance of sampling time.
- Name two common types of sampling and explain each.

Display Slide 16—Unit 3: Sampling.

The remaining learning objectives for this unit are:

- Explain the purpose of sludge sampling and explain how it is done.
- List four types of sampling devices and explain when to use each.
- Explain why sampling preservation is important and identify the types of preservatives used for different types of analyses.

IMPORTANCE OF SAMPLING: 2 minutes

One of the primary activities that occur in the laboratory is the analysis of samples, which will be the focus of this unit. We will discuss the importance of proper sampling, techniques used, and different types of samples. We will also examine different types of sampling devices and discuss the importance and techniques of sample preservation.

*[Review the information in the workbook.]*

SAMPLING TECHNIQUES: 2 minutes

When collecting a sample, it is imperative that you utilize proper sampling techniques.

*[Review the information in the workbook.]*

SAMPLING TIME: 2 minutes

Just as the type of sampler we use can affect the sample, the time at which a sample is collected can have an affect on sample analysis.

*[Review the information in the workbook.]*

TYPES OF SAMPLING: 15 minutes

There are essentially two types of samples collected: grab samples and composite samples.

## Grab Samples

[*Review the defintion of grab samples in the workbook*.]

*[Review the information in the workbook.]*

## Composite Samples

[*Review the defintion of composite sample in the workbook*.]

*[Review the first bullet on composite samples. You can further clarify this bullet by explaining the following:]*

In other words, if the flow at 8 AM is twice the flow at 4 AM, twice as much of the 8 AM flow should be used in the composite sample. In an automatic composite sampler flow based sampling is possible by programming the collector to collect samples after a specified volume has passed by the sampler. That way if the flow at 8 AM is twice the flow at 4 AM the sampler will collect twice as many samples during the 8 AM time period. Therefore, you will have more samples collected during the periods of high flows.

*[Review the remaining information in the workbook.]*

Exercise

This is your first week of work in the lab at a large Wastewater Treatment Plant and the effluent composite sampler is broken. You need to run samples for NPDES compliance. The boss has told the operators to get grab samples, put them in the refrigerator and to read the effluent totalizer every hour. This morning he has told you to take the individual grab samples the operators collected and make the composite sample yourself. You are required to do a flow based composite and you will need about 1,000 ml of sample to conduct all of the required tests. The night shift operator threw a sheet at you as he ran out the door. It reads:

| Time | Totalizer (1,000s) | Time | Totalizer (1,000s) |
|---|---|---|---|
| Midnight | 002215 | 1 PM | 010960 |
| 1 AM | 002740 | 2 PM | 010992 |
| 2 AM | 003925 | 3 PM | 011012 |
| 3 AM | 005037 | 4 PM | 011124 |
| 4 AM | 006135 | 5 PM | 011276 |
| 5 AM | 007500 | 6 PM | 011409 |
| 6 AM | 008555 | 7 PM | 011650 |
| 7 AM | 009869 | 8 PM | 011788 |
| 8 AM | 010050 | 9 PM | 011952 |
| 9 AM | 010650 | 10 PM | 012050 |
| 10 AM | 010725 | 11 PM | 012134 |
| 11 AM | 010801 | Midnight | 012215 |
| Noon | 010859 | | |

How much of the sample collected for the 8 AM to 9 AM time period should be used to make the 24 hour composite sample?

First, you need to calculate the flow for the day: 012215 – 002215 = 10,000 (but the totalizer reads in 1,000 gallons) So its 10,000 * 1,000 = 10,000,000 gallons. Second, you need to calculate how much water passed through the plant between 8 AM and 9 AM: 010650 – 010050 = 600 * 1,000 = 600,000 gallons. Third, you need to calculate what percent of the total daily plant flow passed through the plant between 8 AM and 9 AM: (600,000 / 10,000,000)*100 = 6 %. From this you can see that since 6% of the total plant flow passed through the plant between 8 AM and 9 AM, 6 % of the final composite sample you need to make should be from the 8 AM to 9AM sample. It was stated in the problem above that you will need 1,000 ml of the composite to run all of your tests. So 6% of the 1,000 ml should be from the 8 AM - 9 AM sample. 1,000 * 6% = 60 ml.

**Ans:** You need to add 60 ml of the 8 AM - 9 AM sample to you composite sample.

SLUDGE SAMPLING: 2 minutes

Although you will collect many different types of samples in the lab, sludge sampling is one type of sample that merits special attention in this module.

*[Review the information in the workbook.]*

SAMPLING DEVICES: 2 minutes

Just as we mentioned in Unit 1 that there are many different types of glassware and preparatory equipment, there are also many types of sampling devices we can use. We will focus our discussion on four common sampling devices.

Types of Sampling Devices

*[Review the information in the workbook on types of sampling devices.]*

SAMPLING PRESERVATION: 5 minutes

*[Review the information in the workbook on sample preservation.]*

Exercise

1. Explain the importance of collecting a representative sample.

**Ans:** If the results of a non-representative sample are used to adjust the treatment process, it could very likely upset the process and lead to less than optimal treatment.

2. What is the single biggest source of errors in laboratory results?

**Ans:** Sampling errors.

3. Explain how to manually prepare a flow based composite sample.

**Ans:** Collect grab samples at regular time intervals and store those samples in the refrigerator. At the completion of the compositing time frame, examine the flow data. Calculate the total flow for the day and the flow for each of the time frames during which samples were collected. Calculate the percent of flow that passed through the plant during each of the samples time frame. Use that percent to calculate the amount of each individual sample that will be used to create the composite sample.

*[Review Key Points]*

Now that we have an overview of the importance of sampling and various sampling techniques and types, we will begin discussing specific laboratory procedures in the next unit.

UNIT 4: 45 minutes

Display Slide 17—Unit 4: Laboratory Procedures.

At the end of this unit, you should be able to:

- List common laboratory analyses performed in wastewater treatment.
- Describe the purpose of Solids, pH, Alkalinity, Biochemical Oxygen Demand, Chemical Oxygen Demand, Coliform, Metals, Chlorine Residual, Nitrogen and Phosphate laboratory analyses.

Display Slide 18—Unit 4: Laboratory Procedures.

The remaining learning objectives for this unit are:

- List the equipment needed to conduct common wastewater treatment analysis.
- Describe the general procedure that should be followed for the common wastewater treatment laboratory analysis.

In this unit, we will review eight different categories of analyses that may occur in a laboratory: solids, pH and alkalinity, oxygen determination, microbiological procedures, metals procedures, chlorine procedures, nitrogen/ammonia procedures and phosphate procedures. Please keep in mind that we will just be highlighting the basics of each category of analyses and this is not meant to be a detailed explanation of how these analyses are to be conducted. Our discussion will focus on the significance and the approved analysis procedure for each type of analyses. For each type of analyses, the reference information is included in your workbook so that you can find the approved procedure for that particular analysis. In addition, your workbook includes details on sampling collection locations and equipment needed to conduct the analysis.

SOLIDS: 10 minutes

*[Review the introductory paragraphs in the workbook.]*

There are four types of solids analyses we will review: dissolved solids, settleable solids, total suspended solids and total solids (volatile and fixed).

## Dissolved Solids

*[Review the significance and approved analysis procedure for dissolved solids.]*

Settleable Solids

*[Review the significance and approved analysis procedure for settleable solids.]*

Total Suspended Solids

*[Review the significance and approved analysis procedure for total suspended solids.]*

Total Solids (Volatile and Fixed)

*[Review the significance and approved analysis procedure for total solids.]*

Exercise

1. List the four types of solids analyses and explain the significance of each.

**Ans:** Dissolved solids. Solids analyses are important in the control of biological and physical wastewater treatment processes.

Settleable Solids. This analysis indicates the volume of solids removed by sedimentation.

Total Suspended Solids. This analysis indicates the quality of the influent wastewater and is used to gauge plant performance at various locations in the plant. It is also used to verify discharge compliance.

Total Solids (Volatile and Fixed). Total solids are the combined amounts of suspended and dissolved material in the sample. It is comprised of volatile and fixed solids. Volatile solids are composed of organic compounds which are either plant or animal origin (such as waste material that can be treated biologically). Fixed solids are inorganic compounds such as sand, gravel and minerals.

PH AND ALKALINITY: 5 minutes

Our second category of analyses is pH and alkalinity.

pH

*[Review the significance and approved analysis procedure for pH.]*

Alkalinity

*[Review the significance and approved analysis procedure for alkalinity.]*

Exercise

1. What is the significance of conducting pH and Alkalinity analyses?

**Ans:** pH: The purpose of the test is to determine whether the pH at various points of the treatment process is favorable for the process.

Alkalinity: Alkalinity is a measure of the wastewater's ability to neutralize acids. It is an indirect measure of the concentration of carbonate, bicarbonate and hydroxide in the sample.

2. When conducting a pH analysis, the sample is collected from which locations?

**Ans:** From the influent, recirculated sludge, digester supernatant and plant effluent.

3. When conducting an alkalinity analysis, the sample is collected from which locations?

**Ans:** The sample is collected from the influent and effluent.

OXYGEN DETERMINATION: 6 minutes

Oxygen determination involves three different types of analyses: dissolved oxygen, biochemical oxygen demand and chemical oxygen demand.

Dissolved Oxygen

*[Review the significance and approved analysis procedure for dissolved oxygen.]*

Biochemical Oxygen Demand (BOD)

*[Review the significance and approved analysis procedure for biological oxygen demand.]*

Chemical Oxygen Demand (COD)

*[Review the significance and approved analysis procedure for chemical oxygen demand.]*

Exercise

1. Explain the principal difference between BOD and COD analyses.

**Ans:** BOD quantifies the depletion of oxygen due to biological activity over a 5 day period. COD uses a chemical reflux to quantify the amount of oxygen used by a sample. COD analyses can be run in a matter of hours rather than days.

MICROBIOLOGICAL PROCEDURES: 5 minutes

There are two microbiological procedures we will review: total coliform and fecal coliform.

## Total Coliform

*[Review the significance and approved analysis procedure for total coliform.]*

Fecal Coliform

*[Review the significance for fecal coliform.]*

Review the approved analysis procedure for fecal coliform.

Exercise

1. Explain the purpose of testing a WWTP's effluent for total coliform.

**Ans:** It is used as a surrogate to indicate the quantity of human or animal waste in finished water.

2. Explain the purpose of testing a WWTP's effluent for fecal coliform.

**Ans:** It is used as a surrogate to indicate the quantity of human or animal waste in finished water. The presence of fecal coliforms indicates that disease producing organisms may be present in the sample tested.

METALS PROCEDURES: 5 minutes

Metals procedures involve conducting analyses for aluminum, iron and copper.

## Aluminum

*[Review the significance and approved analysis procedure for aluminum.]*

Iron

*[Review the significance and approved analysis procedure for iron.]*

Copper

*[Review the significance and approved analysis procedure for copper.]*

Exercise

1. Why are there limits placed on the amount of certain metals that can be discharged from a WWTP?

**Ans:** High concentrations of some metals can be toxic to some forms of aquatic life.

CHLORINE PROCEDURES: 4 minutes

There is only one chlorine procedure we will review, which is total residual chlorine.

Total Residual Chlorine

*[Review the significance for total residual chlorine*.]

*[Review the approved analysis procedure for total residual chlorine.]*

Exercise

1. What is the significance of conducting a chlorine analysis?

**Ans:** To determine the presence of chlorine in the discharge since it is toxic to aquatic life.

NITROGEN/AMMONIA PROCEDURES: 6 minutes

Nitrogen/ammonia procedures involve analyses for nitrate/nitrite, ammonia and total kjeldahl nitrogen, commonly referred to as TKN.

## Nitrate/Nitrite

*[Review the significance and approved analysis procedure for nitrate/nitrite.]*

Ammonia

*[Review the significance and approved analysis procedure for ammonia.]*

Total Kjeldahl Nitrogen (TKN)

*[Review the significance and approved analysis procedure for TKN.]*

Exercise

1. List the three types of nitrogen/ammonia analyses and explain the significance of each.

**Ans:** Nitrate/Nitrite: The presence of nitrate in the effluent of a WWTP is significant because it is an essential nutrient for algae growth. Excessive amounts of nitrate can cause algae blooms. When the algae die and decays it can exhibit a large oxygen demand on the stream which in turn can cause the fish and other aquatic life to be killed.

Ammonia: Ammonia in the effluent of a wastewater treatment plant can create a significant oxygen demand in the receiving stream. This demand will lower the amount of DO available for aquatic life and lead to fish and aquatic life kills.

TKN: TKN is the sum of organic nitrogen and the ammonia nitrogen in a sample.

PHOSPHATE PROCEDURES: 4 minutes

As with chlorine procedures, there is only one phosphate procedure to be reviewed.

Phosphate

*[Review the significance and approved analysis procedure for phosphate.]*

Exercise

1. What is the significance of conducting a phosphate analysis?

**Ans:** Wastewater is usually quite rich in phosphorus compounds and its removal is extremely important because their presence can stimulate the growth of algae. These growths can be a great nuisance and the die-off of algae will create a large DO demand in the receiving stream.

[*Review Key Points]*

UNIT 5: 17 minutes

Display Slide 19—Unit 5: Laboratory Quality Assurance and Quality Control.

At the end of this unit, you should be able to:

- Explain why a quality control plan is important and list the important components of a quality assurance plan.
- Explain the importance of a QA manual, training, chain of custody, bench sheets and reporting to a quality assurance plan.
- Explain why quality control is important.

Display Slide 20—Unit 5: Laboratory Quality Assurance and Quality Control.

The remaining learning objective for this unit is:

- Explain the importance of each of the following and give a brief description of how each analysis is conducted:
    - Duplicates
    - Spikes
    - Blanks
    - External Standards
    - Blinds

QUALITY ASSURANCE: 10 minutes

As a result of the many types of analyses performed in the laboratory, a lot of data is generated. As a treatment plant operator, you have a responsibility to ensure that quality data is produced. This is known as quality assurance, which we will discuss further in this unit. How many of you are familiar with a Quality Assurance Plan? What are some of the things included in a Quality Assurance Plan?

[*Write participant responses on flipchart*.]

*[Review the information in the workbook on the elements of a QA plan, focusing on the items participants did not mention.]*

QA Manual

*[Review the information in the workbook.]*

Training

*[Review the information in the workbook.]*

## Chain of Custody

[*Review the defintion of chain of custody in the workbook*.]

*[Review the information in the workbook.]*

Bench Sheets

As you can imagine, all of the data generated in the laboratory must be documented in some manner. A bench sheet is commonly used for this purpose.

*[Review the defintion of bench sheet in the workbook*.]

*[Review the information in the workbook.]*

Reporting

Once the data has been collected and recorded on the bench sheet, it would be easy to assume you are done working with the data. Unfortunately, this is not the case, as the data is typically used for reporting purposes.

*[Review the information in the workbook.]*

[*Review the defintion of data reduction in the workbook*.]

*[Review the defintion of data validation in the workbook*.]

*[Review the remaining information in the workbook.]*

QUALITY CONTROL: 7 minutes

Up to this point, we have talked about assuring the quality of the data, but now we will move on to the topic of quality control. While quality assurance focuses on the quality of the data, quality control procedures assure the accuracy of laboratory analyses. There are specific procedures used to verify that the data generated is accurate.

## Duplicates

[*Review the defintion of duplicate analysis in the workbook*.]

*[Review the remaining infroamtion in the workbook.]*

## Spikes

[*Review the defintion of spikes in the workbook*.]

*[Review the remaining information in the workbook.]*

## Blanks

[*Review the defintion of blanks in the workbook*.]

## External Standards

[*Review the defintion of external standards in the workbook*.]

## Blinds

[*Review the defintion of blinds in the workbook*.]

Exercise

1. List 5 elements of a good QA plan.

**Ans:** Any five of the following should be included in a QA plan: a cover sheet with plan approval signatures, a laboratory organization chart, sample control and documentation procedures, Standard Operating Procedures (SOPs) for each analytical method, analyst training procedures, equipment preventative maintenance procedures, calibration procedures, quality control procedures, and data reduction, validation, and reporting procedures.

2. Duplicates are used to demonstrate the _____ of a laboratory method.

**Ans:** precision

3. Spikes are used to demonstrate the _____ of a laboratory method.

**Ans:** accuracy

4. A well written QA manual can be used for what other purpose?

**Ans:** B.

A is not the correct answer because even a poorly written QA plan makes a fine door stop. C is not true because a lab QA manual only deals with the laboratory issues not plant operations. D is not true because even if the QA manual is perfect, the QA Officer must verify that the procedures contained in the manual are being adhered to.

[*Review Key Points*]

UNIT 6: 28 minutes

Display Slide 21—Unit 6: Data Handling, Records and Reporting.

At the end of this unit, you should be able to:

- Define Method Detection Limit.
- List two types of laboratory records, explain the significance of each and explain how results should be recorded and stored.

Display Slide 22—Unit 6: Data Handling, Records and Reporting.

- Identify the data required to complete a Discharge Monitoring Report (DMR) and explain why each piece of data is important.
- Explain the purpose of the Frequency of Analysis and Sample Type sections of the DMR.
- List the three main sections of a DMR and give a brief explanation of what is included in each section.

Display Slide 23—Unit 6: Data Handling, Records and Reporting.

The final learning objectives for this unit are:

- Specify the deadline for submission of the DMR.
- Explain the requirements for non-compliance reporting.
- Explain the requirements of the records retention policy.

DATA HANDLING: 5 minutes

We have discussed the fact that a lot of data is collected as a result of the analyses conducted in the laboratory. It is usually necessary to do something with this data, which is what we mean when we use the term "data handling." In this unit, we will review two ways in which data is typically handled: laboratory mathematics and method detection limits.

## Laboratory Math

Since most of the data collected is numerical data, you can imagine that mathematics play an important role in working with the data. While we will not discuss specific mathematical formulas and computations in this unit, we will discuss areas where math will be required in the lab.

### Molecular Weights and Solution Strengths

One of the first areas where math skills are necessary is when computing molecular weights and solution strengths.

*[Review the information in the workbook.]*

### Analytical Results

Performing mathematical computations can also be necessary when handling the results of a particular analysis.

*[Review the first bullet in the workbook, and then share the following with the participants:]*

For instance, if a sample had to be diluted prior to analysis, the amount of the dilution would have to be taken into account prior to reporting the result. Similarly, if a sample was concentrated by a digestion or filtration prior to analysis, an adjustment to the sample result would be required.

*[Review the remaining bullet item in the workbook.]*

## Method Detection Limits

Another type of data handling involves method detection limits, which is what we will now review.

*[Review the information in the workbook.]*

[*Be sure to review the definition of limit of resolution*.]

LABORATORY RECORDS: 5 minutes

Now that we have discussed data handling, it is necessary to spend a few minutes discussing laboratory records. Since so much data is collected in the lab, proper recordkeeping becomes an important task.

## Analytical Results

The first type of record we will discuss are records of analytical results.

*[Review the information in the workbook.]*

Analytical records are also usually the only documentation that a particular sample was run at a particular time and produced the reported result. It may be necessary to produce this documentation if the operation of your facility is questioned by the regulatory community or local citizens.

## QC Results

In the previous unit, we discussed the role of quality assurance and quality control in an analytical laboratory. Quality control records are another type of record that must be kept.

DISCHARGE MONITORING REPORTS: 18 minutes

The final part of our unit will be spent reviewing the Discharge Monitoring Report, or, DMR. The DMR is the key component in determining compliance with NPDES permit requirements. The DMR completion process consists of reporting operational, flow, and analytical results from the plant, usually on a monthly basis. By examining these results, the regulatory agency can determine if the facility has been operating within its permit requirements.

Appendix B of your workbook is a sample of the DMR. Review it and familiarize yourself with the different sections on the form. The top identifies the facility and monitoring period. The left side of the form lists the parameters for which monitoring is required. This is just a sample, so it may list parameters that are different from those on your facility's DMR. The middle of the form is where the results of the testing conducted during the month are reported. The right side of the form lists the monitoring requirements for each of the regulated parameters.

When examining the sample DMR, note that some cells are marked with a series of X's and some are marked with a series of asterisks. The X's indicate where your permit requirement would be listed and the asterisks indicate where you would report results of the analyses conducted, meter readings, or operational results.

## Required Data

Now that we have an idea of what the DMR is and why it is important, let's discuss the data required to be on the report.

*[Review the information in the workbook.]*

Some NPDES permits allow higher concentration and loading limits during the months of November through April. The rationale for this changing limitation is related to the relative amounts of use the receiving stream experiences during the different seasons.

### Flow

*[Review the information in the workbook.]*

### Analytes

*[Review the first bullet, and then share the following with the participants:]*

That is, if the receiving stream is known to contain significant amounts of a particular toxin, the WWTP will likely be required to limit the amount of the toxin that is discharged, regardless of whether there is any data to indicate that it has been found at any time in their discharge. This is a concept known as total loading in which the maximum amount of the toxin the stream is capable of receiving is divided up among all of the dischargers to that stream.

### Removals

*[Review the information in the workbook.]*

### Operations

*[Review the information in the workbook.]*

## Data Collection

The DMR also has some specific data collection requirements, which we will review now.

### Frequency of Analysis

*[Review the information in the workbook.]*

### Sample Type

*[Review the information in the workbook.]*

Data Manipulation

Next we will discuss data manipulation as it relates to the DMR.

*[Review the information in the workbook.]*

[*Be sure to review the defintion of geometric mean in the workbook.]*

*[Review the remaining information in the workbook.]*

Our final topic regarding the DMR is reporting. We will review key pieces of information about completion of the DMR.

## Report Completion

*[Review the information in the workbook.]*

## Facility Identification and Monitoring Period

*[Review the information in the workbook.]*

Testing Results Reporting

*[Review the information in the workbook.]*

Identification of Responsible Party

*[Review the information in the workbook.]*

Report Submission

*[Review the information in the workbook.]*

Non-Compliance Reporting

*[Review the information in the workbook.]*

## Record Retention

There are many different types of records in a WWTP and all of the records are important. If space permits, permanent storage of all records is desirable. Realistically, however, storage of all plant records is not typically possible.

*[Review the information in the workbook.]*

Exercise

1. What are the two general types of laboratory records?

**Ans:** Analytical results and QC results.

2. Which of the following information does not need to be reported on a DMR?

**Ans:** c. Routine chemical deliveries are not reportable. However, if a spill of a treatment chemical occurred while receiving the chemical it would, most likely, be reportable.

3. DMRs must be submitted within _____ days of the end of the monitoring period.

**Ans:** 10.

4. Completed DMRs and the data used to complete them must be maintained for at least _____ years after the date of submission, sample measurement, report or application.

**Ans:** 3.

[*Review Key Points*]

We have now completed all the topics in the module. You should have a good overview of what types of equipment are found in the lab, what safety and health issues need to be addressed, what kind of analyses are conducted, what role quality assurance and quality control play in the lab and what needs to be done in terms of data handling, records and reporting. Are there any questions before we end?

The next section contains Appendices for Module 12.

*[Thank participants and dismiss.]*