

# Running the “Sewer Science” Laboratory in Your Classroom

## Before You Start

### Obtain an Assistant

Try to have an adult or student assistant in your classroom for Days 3 through 7 of the lab. A summary of tasks for the assistant is provided below. Note: If you do not find an assistant, you will need to complete the assistant-designated tasks in addition to teaching the laboratory.

### Gather Laboratory Materials

- ◆ Most of the materials needed for the lab (including the ingredients for the wastewater) are in the kit. Here are the materials that the teacher must provide:
  - 2 mortar and pestles (for Day 3 only)
  - 5 balances (Day 3 only)
  - 2 graduated cylinders (Day 3 only)
  - eight 1-liter beakers for Day 3; 4 beakers for the rest of the week
  - two 2-liter beakers or flasks
  - 8 to 15 microscopes (Day 5 only)
  - microscope slides and cover slips (Day 5 only)
  - dish detergent
  - bleach

### Review Treatment Plant Diagram on Pages 42-43 of Student Workbook

- ◆ On the last page of the student workbook, there is a schematic of a local wastewater treatment plant. Use this diagram throughout the week; it helps reinforce the similarities between the classroom lab and an actual treatment plant.
- ◆ Reinforce with your students that this is NOT a drinking water treatment process. This process is treating household wastewater so it is clean enough to discharge into the San Francisco Bay or the Delta.

## Tasks Performed by Teaching Assistant in the Sewer Science Lab

Note: As the assistant, you will need to modify how you help depending on the teachers method of teaching and what they want to emphasize. Check with the teachers to see how they want to handle the lab testing. For example one teacher may want students to collect own samples from the tanks; another may want to have one beaker and have students collect sample from that. Be sensitive to the individual teachers approach to teaching this lab.

### Day 3

- ◆ Place the sedimentation tanks at sinks
- ◆ Check all tank sampling ports to make sure sealed
- ◆ Make sure lab analysis equipment is all set up and ready to go
- ◆ Put out trays with products that will simulate wastewater (Trays should contain the product and a balance or a graduated cylinder)
- ◆ Help students tare balances and weigh items
- ◆ Help combine all synthetic wastewater ingredients into tank
- ◆ Mix and take a 500 mL sample of the well mixed synthetic wastewater
- ◆ Help with analysis
- ◆ Cover tank

### Day 4

- ◆ Set up testing stations
- ◆ Help students collect samples from mid-depth of tank for analysis
- ◆ Help with analysis
- ◆ Transfer wastewater from middle of the sedimentation tank to aeration tank
- ◆ Plug in aquarium pump
- ◆ Add 1 liter of activated sludge
- ◆ Cover tank
- ◆ Clean up testing stations and set them up for next class
- ◆ Drain all the remaining wastewater from the sedimentation tank through a colander to remove solids; dispose in trash.
- ◆ Wash sedimentation tank. Turn upside down to dry.

**Day 5**

- ◆ Collect sludge sample for microscopic examination - try to get heavy sludge concentration
- ◆ Put the sample in petri dishes ready for student use. Have eyedroppers near dishes.
- ◆ Check that all ports are closed on sedimentation tank
- ◆ Transfer all wastewater to the sedimentation tank
- ◆ Add 75 mL alum to the wastewater
- ◆ Help with microscope work and organism identification
- ◆ Wash aeration tank - use bleach to disinfect. Turn upside down to dry.

**Day 6**

- ◆ Set up all testing stations
- ◆ Remove 500 mL sample of wastewater that is above the settled activated sludge.
- ◆ Help students run analyses
- ◆ Run 2 to 8 liters of tap water through filter, until the effluent is clear. Do not let the filter run dry. Clamp bottom hose to trap the tap water in the filter until ready to filter the wastewater.
- ◆ Filter 1 liter of the wastewater to the sink/drain.
- ◆ Filter a second liter of treated wastewater and collect effluent for analysis.
- ◆ Clean up testing stations and set them up for next class

**Day 7**

- ◆ Set up all testing stations
- ◆ Run all analyses on filtered wastewater
- ◆ Clean sedimentation tank. Disinfect with bleach and turn upside down to dry.
- ◆ Clean up testing stations and set them up for next class

# Daily Activities & Tips

## DAY 1

- ◆ A 13-minute video, "H2O TV," should be in your kit. The video is packed with information. First, it reminds students of the water cycle and notes that humans have altered this cycle. It shows the Sierra snow pack and California reservoirs. Then it discusses what happens to that water after it has been used in homes and industry. It also shows storm water run-off and notes that this water is different than wastewater and that both are pollution sources for the Bay. The 3 key steps of wastewater treatment are presented followed by a discussion of what THEY can do to protect the Bay.
- ◆ Give the initial reading assignment so the students will understand the first day of the lab and at least 2 of the analytical methods.

## Day 2

- ◆ Prepare several waste solutions from available materials. Examples: sand in water, milk in water, chips in water, coffee or tea in water.
- ◆ Demonstrate the use of the COD analyzer, ammonia kit, turbidity meter, and pH meter or paper using the prepared waste solutions. Be sure to emphasize safety and chemical waste handling.
  - ◆ Chemical oxygen demand requires the most assistance; the vials contain sulfuric acid so students should wear gloves and protective eyewear. You may want this test to be the most supervised. Alternatively, you can do the analysis throughout the lab in the front of the class.
  - ◆ Ammonia is straightforward but will initially confuse the students; once they try it, it quickly becomes their favorite test (the ampoule is under a vacuum and when they break the tip they are stunned that the liquid enters the ampoule and rapidly changes color).
  - ◆ Turbidity is a relatively simple test but needs to be presented to the students once; they need to know which buttons to press and to use distilled water as the "zero" sample prior to reading their sample.
  - ◆ pH is a simple test, whether using the meter or the pH paper; demonstrate once.

- ◆ WASTE DISPOSAL
  - ammonia ampoules should be stored in a plastic jar and returned to the plant for disposal
  - the caps of the used COD test tubes should be marked with a sharpie pen to show they've been used and then the capped tubes should be placed back in the styrofoam COD test tube package
  - all wastewater and bacteria can be disposed of down the sink drain
  - there are strainers to collect the solids (plastics/toilet paper) to avoid plugging the drain

### Day 3

- ◆ Break the students into 8 groups; each group will be responsible for one ingredient of the waste; students should stay in these groups the rest of the week for the analytical tests. This is the first day you will analyze the chemistry of the wastewater; you will repeat these tests throughout the week.
- ◆ Set up a minimum of 4 work stations for the analytical tests:
  - pH
  - turbidity
  - chemical oxygen demand
  - ammonia
- ◆ Instruct student groups to analyze the simulated wastewater for the initial waste parameters.
- ◆ Verify that **fresh** activated sludge will be delivered in the morning. Old or improperly stored sludge will not contain living organisms. This will adversely affect the results.

### Day 4 - Primary Treatment

- ◆ Store fresh activated sludge at room temperature. Use one of the supplied aquarium pumps and tubing to aerate the sludge sample.
- ◆ If you like to give students opener questions to answer either written or orally, here are some sample questions:
  - What happens in primary treatment?
  - Why is density important during this stage of treatment?
  - What is turbidity?
  - What does pH measure? Why do we care about pH?
- ◆ Wear gloves to transfer the activated sludge into the aeration basin.

## Day 5 - Biological Treatment

- ◆ Make sure the students understand that we added microorganisms from the wastewater treatment plant. Pathogens may be present.
- ◆ If there was a wastewater lab during the previous period, use 5% bleach-water on the surfaces and the microscopes before using.
- ◆ Play the U.S. EPA video of wastewater microorganisms throughout the lab. This video shows live organisms similar to those likely to be observed by the students.
- ◆ Students must wear gloves if they are making the slides or touching the slides and microscopes.
- ◆ Have students look for rotifers, free-swimming and stalked ciliates, nematodes, round worms, large brown flocs of bacteria, and filamentous bacteria. We have also observed microorganisms that look like mites/ticks and egg sacs filled with little black eggs or worms.
- ◆ Explain how to determine the size of the organisms being observed:
  - Microns = micrometers =  $\mu\text{m}$
  - $1,000 \mu\text{m} = 1 \text{ mm}$
  - Look at a ruler under the microscope at each power level.
  - Measure the number of millimeters you can see across the diameter of the viewing area at each power
  - Multiply that number by 1,000 - that is the length in microns, or micrometers, across your view
  - Use this information to estimate the size of each organism that you find
  - EXAMPLE, if using the 100x power and you measure 5 millimeters across, that equals  $5,000 \mu\text{m}$ . Then if you find an organism that takes up half the diameter of the view, it is approximately  $2,500 \mu\text{m}$  in length.
- ◆ After class, have students spray down the surfaces with bleach-water and then thoroughly wash their hands.

## Day 6 - Tertiary Treatment

- ◆ Remind students about safety and proper waste handling.
- ◆ Students should still wear gloves if they will be working with the wastewater. Although the vast majority of organisms will have settled to the bottom of the tank, a few may still remain in the wastewater.
- ◆ **IMPORTANT** - The filters need to stay wet throughout the day. When explaining the filtration task, stress that the water already sitting in the filter is either tap water or wastewater from a previous lab. They will need to open the clamp at the bottom of the filter and add some of their wastewater to the top of the filter. They should be instructed to never let the top of the filter go dry. After they have added about one liter of the wastewater into the filter, they can start collecting effluent from the bottom of the filter. After they have poured all the water through the filter, they should close the clamp at the bottom **BEFORE** the top of the filter gets dry.
- ◆ After filtration, remember to disinfect the wastewater (2 drops of bleach per liter of filtered wastewater).

## Day 7

- ◆ Analyze the filtered wastewater.
- ◆ Be sure all the students have complete data tables for the week
- ◆ Assign graphs and conclusions; make sure they understand what you'll be expecting for their final workbooks/final reports.
- ◆ Be prepared to give a short quiz (sample questions provided below).

## Follow-Up

- ◆ Provide time for an open discussion period to address questions about the lab and the local treatment plant. An option is to arrange for a presentation by local wastewater treatment plant staff or a plant tour.

Name: \_\_\_\_\_

Date: \_\_\_\_\_ Period: \_\_\_\_\_

## Wastewater Treatment Quiz

1. \_\_\_\_\_ is a physical process used in wastewater treatment to remove particles that are more dense than water.
2. Secondary treatment uses \_\_\_\_\_ to consume wastes.
3. The chemical, \_\_\_\_\_, is sometimes added to assist with coagulation and flocculation.
4. Common substances used in a filter are \_\_\_\_\_ and \_\_\_\_\_.
5. Wastewater treatment plants use UV light or \_\_\_\_\_ to disinfect the water.
6. The measure of how cloudy the water looks is called \_\_\_\_\_.
7. \_\_\_\_\_ measures the amount of dissolved oxygen that would be removed from the water in order to oxidize pollution.
8. The toxic nitrogen-containing compound in wastewater, originating from urine, is \_\_\_\_\_.
9. Why is it important to keep metals and pesticides away from sink and toilet drains?  
\_\_\_\_\_
10. A treated wastewater has a pH of 7.4, a COD of 5 mg/L and a turbidity of 28. Would it be legal to discharge this treated wastewater into the Bay? \_\_\_\_\_ Why or why not?  
\_\_\_\_\_
11. Why do chemicals that get into our storm drains reach the Bay?  
\_\_\_\_\_
12. What was the most important concept/fact you learned during this lab, and why?  
\_\_\_\_\_

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13. What was the most difficult concept for you during this lab, and why?

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**A DRAWING!** Sketch the stages of wastewater treatment. Remember to label your drawing!



# Wastewater Treatment Quiz

## Answer Key

1. **Sedimentation** is a physical process used in wastewater treatment to remove particles that are more dense than water.
2. Secondary treatment uses **microorganisms** to consume wastes.
3. The chemical, **aluminum sulfate (alum)**, is sometimes added to assist with coagulation and flocculation.
4. Common substances used in a filter are **charcoal** and **sand**.
5. Wastewater treatment plants use UV light or **chlorine/chlorination** to disinfect the water.
6. The measure of how cloudy the water looks is called **turbidity**.
7. **Chemical oxygen demand (COD)** measures the amount of dissolved oxygen that would be removed from the water in order to oxidize pollution.
8. The toxic nitrogen-containing compound in wastewater, originating from urine, is **ammonia**.
9. Why is it important to keep metals and pesticides away from sink and toilet drains?  
**Wastewater treatment plants are not designed to remove these chemicals from water.**
10. A treated wastewater has a pH of 7.4, a COD of 5 mg/L and a turbidity of 28. Would it be legal to discharge this treated wastewater into a "sensitive bay or river" ? **No** Why or why not? **The turbidity is too high.**
11. Why do chemicals that get into our storm drains reach the Bay? **Storm water is not sent to a wastewater treatment plant. Storm drains are connected directly to the Bay.**
12. What was the most important concept/fact you learned during this lab, and why?  
**While there are no right or wrong answers, your contact at the wastewater treatment plant may be interested in the responses.**

13. What was the most difficult concept for you during this lab, and why?

**While there are no right or wrong answers, your contact at the wastewater treatment plant may be interested in the responses.**

**A DRAWING!** Sketch the stages of wastewater treatment. Remember to label your drawing!

**The sketches may look like the classroom lab models or more like the workbook diagram of a local wastewater treatment plant. In either case, look for all three steps: primary (sedimentation), secondary (biological), and advanced (filtration and disinfection).**

## **Classroom Signs**

On the following pages there are signs that you can copy and use in your classroom. There are signs for each of the four (4) water quality analyses. There are also signs for all eight (8) substances used to create the simulated wastewater.

# CHEMICAL OXYGEN DEMAND

# pH

# TURBIDITY

# AMMONIA CONCEN- TRATION

# Dried Used Coffee Grounds

# Breakfast Cereal

# Pet Food

# Plastic

# Baking Soda

# Toilet Paper

# Ammonia

# Vegetable Oil