

Unit 6: The Treatment of Wastewater

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Unit 6: The Treatment of Wastewater

Objectives: Each student will be able to:

- Discuss the importance of treating **wastewater**
- Distinguish between the two methods of treating wastewater

Words to Remember:

- **absorption field**
- **aeration**
- **cake**
- **digest**
- **disinfect**
- **grit**
- **hydrologic cycle**
- **impurities**
- **landfill**
- **microorganisms**
- **nutrients**
- **oxygen**
- **perforated**
- **primary treatment**
- **scum**
- **secondary treatment**
- **sedimentation tank**
- **septic system**
- **septic tank**
- **sewage**
- **sludge**
- **tertiary treatment**
- **wastewater**
- **wastewater treatment plant**

Background Information

The water we use everyday is recycled back to the environment. This recycling process is known as the **hydrologic cycle**. A name for used water is **wastewater**. By recycling wastewater, we are renewing our water supplies.

Sometimes wastewater is not clean. Used water may come from factories, homes or farms. But it still must be returned to the free environment.

Before the 19th century, wastewater was often dumped into the streets and streams of all sizes. This dumping polluted many water supplies. Bacteria in the water spread diseases. To protect water supplies, we now collect and treat (clean) wastewater. Treating wastewater helps protect public health and water quality.

We use two methods to treat wastewater. These are **wastewater treatment plants** and **septic systems**. **Wastewater treatment plants** clean used water from public sources. The process is

very much like the process used by water treatment plants to clean water *before* it is used. **Septic systems** use a different process to clean wastewater. They are used to treat wastewater from private or rural sources.

Wastewater Treatment Plants. The purpose of **wastewater treatment plants** is to clean water before releasing it into the environment. Most homes, businesses and other public buildings connect to a **wastewater treatment plant** by underground pipes and sewers. The underground pipes and sewers carry billions of gallons of wastewater to treatment plants each day. Another name for wastewater is **sewage**.

The water treatment process usually involves three steps (Figure 6.1):

Step 1: The first step is **primary treatment**. This step removes solid materials from wastewater. Two processes for removing solid materials are **screens** and **sedimentation**. Large screens trap and remove big objects from the wastewater.

The screens keep items such as sticks, branches and large pieces of garbage out of the treatment plant. This solid waste is collected and taken to a **landfill**.

The second process is the **grit** chamber. Grit, such as sand and gravel, settles out (sinks to the bottom) of the wastewater. After the water leaves the grit chamber, the water goes to the *primary sedimentation tank*. Here, particles not screened out are allowed to settle out of the water. **Sludge** is formed from these particles that settle out. The *physical* methods used in this step remove 45 to 50 percent of the **impurities** present.

Step 2: The name of the next step is **secondary treatment**. Secondary treatment uses *biological* methods to further clean wastewater. One method is the use of **microorganisms**, such as bacteria. Bacteria help break down waste products. The bacteria actually absorb and **digest** much of the materials left in wastewater after primary treatment.

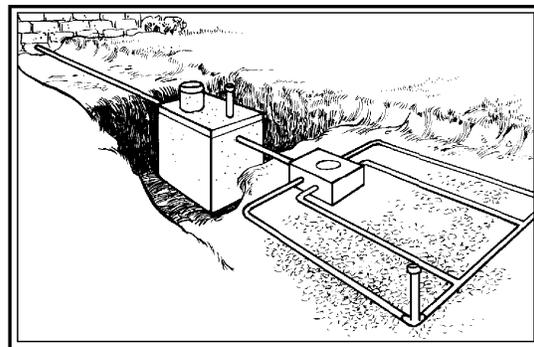
Air is often added at this point. This process is known as **aeration**. **Oxygen** helps speed up bacterial growth. After the bacteria digest a lot of the waste products, the water goes to a *secondary sedimentation tank*. The bacteria and solid particles both settle to the bottom. This process is similar to the *primary sedimentation tank* used in step one. More **sludge** is removed during this step.

The wastewater is then **disinfected**. Disinfecting kills many remaining bacteria. Chemicals, such as **chlorine** (see Unit 5), are used for disinfecting because they kill off the remaining bacteria. After this step, up to 85 percent of the impurities have been removed. Then, clean water may be ready to be released into a nearby water source, such as a stream, lake, or river.

Step 3: **Tertiary treatment** is the third step. This step is not always used. If used, this step can remove even more solids, bacteria or other contaminants. Beds of sand are often used in tertiary treatment to filter out the remaining solid particles. Chemicals may also be added and special filters may be used during this step. After step three, up to 95% of the impurities have been removed. Many communities now use this third step. This treatment provides additional protection to the local lakes and streams.

Sludge is a by-product of treated wastewater. Sludge may be buried in landfills, cleanly burned, or, if properly treated, sludge may be reusable as a fertilizer or as potting material. Before reusing, water and harmful organisms must be removed from sludge. The final product after this process is a dry material called **cake**. It contains **nutrients** and may be used for fertilizing field crops on farms.

Septic Systems. **Septic systems** (Figure 6.2) treat wastewater from homes and businesses not connected to public wastewater treatment plants. A septic system has two main parts: a **septic tank** and an **absorption field**. Water flows through a pipe into a **septic tank**. The



septic tank is a watertight box. It is buried underground. In this box, **sludge** sinks to the bottom and a **scum** layer that contains

grease and other fats or oils, may float to the top. Natural bacteria help to digest the sludge and scum. This part is similar to the process in public wastewater treatment plants.

The leftover water in the tank flows to buried **perforated** pipes. This is called the **absorption field**. The absorption field is where the water slowly seeps from the pipes into the soil. The soil serves as a filter for the wastewater. To work properly, the soil needs to contain the right amount of sand, fine soil, and clay particles. Too much sand and the wastewater moves too fast and contaminates groundwater. Too much clay and the water moves too slow for the system to work. **Microorganisms** in the soil help digest the waste material left in this water.

It is important to place the septic tank and absorption field of a septic system according to Health Department recommendations. The septic system should be a safe distance from certain places, such as wells. Placing a septic system in the wrong place can pollute drinking water supplies.

Homeowners should take good care of their septic tanks. Certain types of chemicals and products should be kept out of septic systems. Some examples of these are drain cleaners, bleach, paper, and certain types of food products. These may cause a septic system to work improperly. Some of the chemicals may even kill the helpful bacteria.

We should keep our water supplies free from contamination. Properly maintaining our wastewater treatment plants and our septic systems helps us clean our wastewater. Clean water may be returned to the environment and recycled back into the water cycle.

Questions for Review

1. What is the name of the process of naturally recycling water?
2. Who has the responsibility for cleaning water after it has been used?
3. What is the name of water that has been used?
4. What are the two types of systems for cleaning wastewater?
5. What is the main difference in the two systems used for cleaning wastewater?
6. List the steps for cleaning water in wastewater treatment plants.
7. How much of the impurities are removed with each step?
8. What is in **cake** that makes it valuable as a farm fertilizer?
9. What treatment method do rural households use to treat wastewater?
10. Name the two parts of a home septic system.

Questions for Thought

1. What would be the danger of releasing used water that has not been properly cleaned back into the environment?
2. Which type of used water do you think is more dangerous: water that has been used in factories and industry or household water?
3. If you were a large scale farmer, how could you turn wastewater from your farm into either a profit or something that is beneficial?
4. What would be a health hazard of placing a septic tank and/or field lines in the wrong place?

Teacher Notes:

Teaching ideas:

- a. Ask a local librarian to run search of "spills" by industry into local water sources. Collect news clippings for enriching class discussion.
- b. Contact someone from the community relations department of a local industrial plant. Ask this person to arrange a visit to their plant so that students can see first hand how this particular industrial plant treats and/or disposes of their wastewater. If a field trip is not possible, ask him to send someone to the meeting to address the same topic.
- c. Make a list of careers involved in the field of wastewater management. Assign various careers to various students; ask each to make a report on his/her assignment at the next meeting.
- d. Have a "career-pal" week. Ask the individuals from these different careers to be a "career-pal" to one student for a week. During this week the student would get to visit with the professional, perhaps on the job, and ask questions. The purpose is for the students to become aware of the variety of careers. A side benefit is that the professional would learn something about 4-H.
- e. Health and Safety Note: Special tests, called "perk" tests, must be performed on soil if a septic system will be needed. These tests have to do with how long it takes liquid to be absorbed into the ground. Local health departments require certain criteria be met before they will approve the installation of a septic system. Ask a guest speaker from the Health Department to visit the class. The purpose of this visit would be to explain how a "perk" test works and the specific criteria that must be met as a condition of installing a septic system.
- f. Try to borrow the plexiglass Septic System Model from one of the regional offices in Extension (see Equipment and Supplies under Bibliography and Resource Materials). This is a good visual demonstration of a septic system.

FIGURE 6.1: The Process of Treating Wastewater

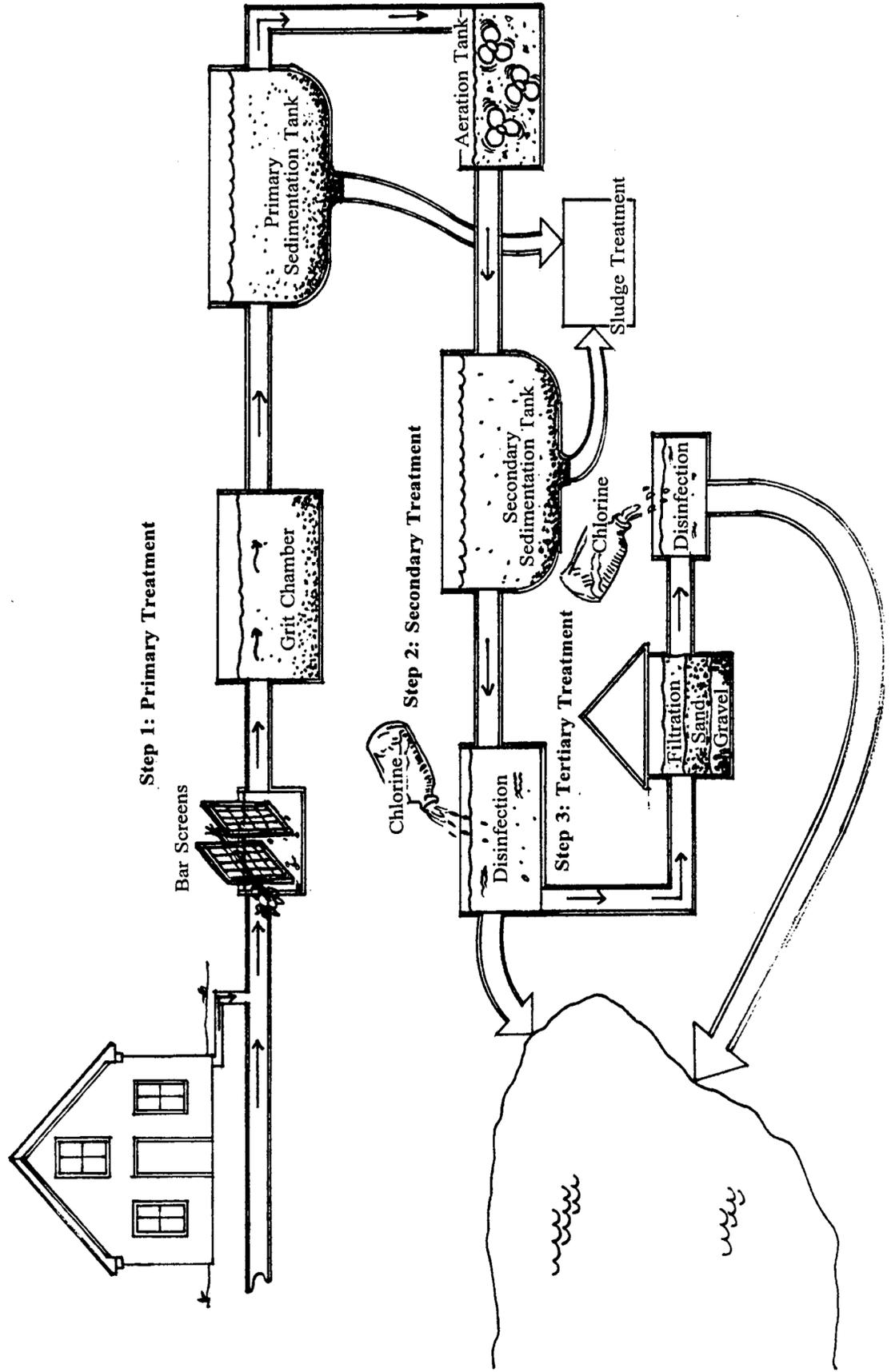
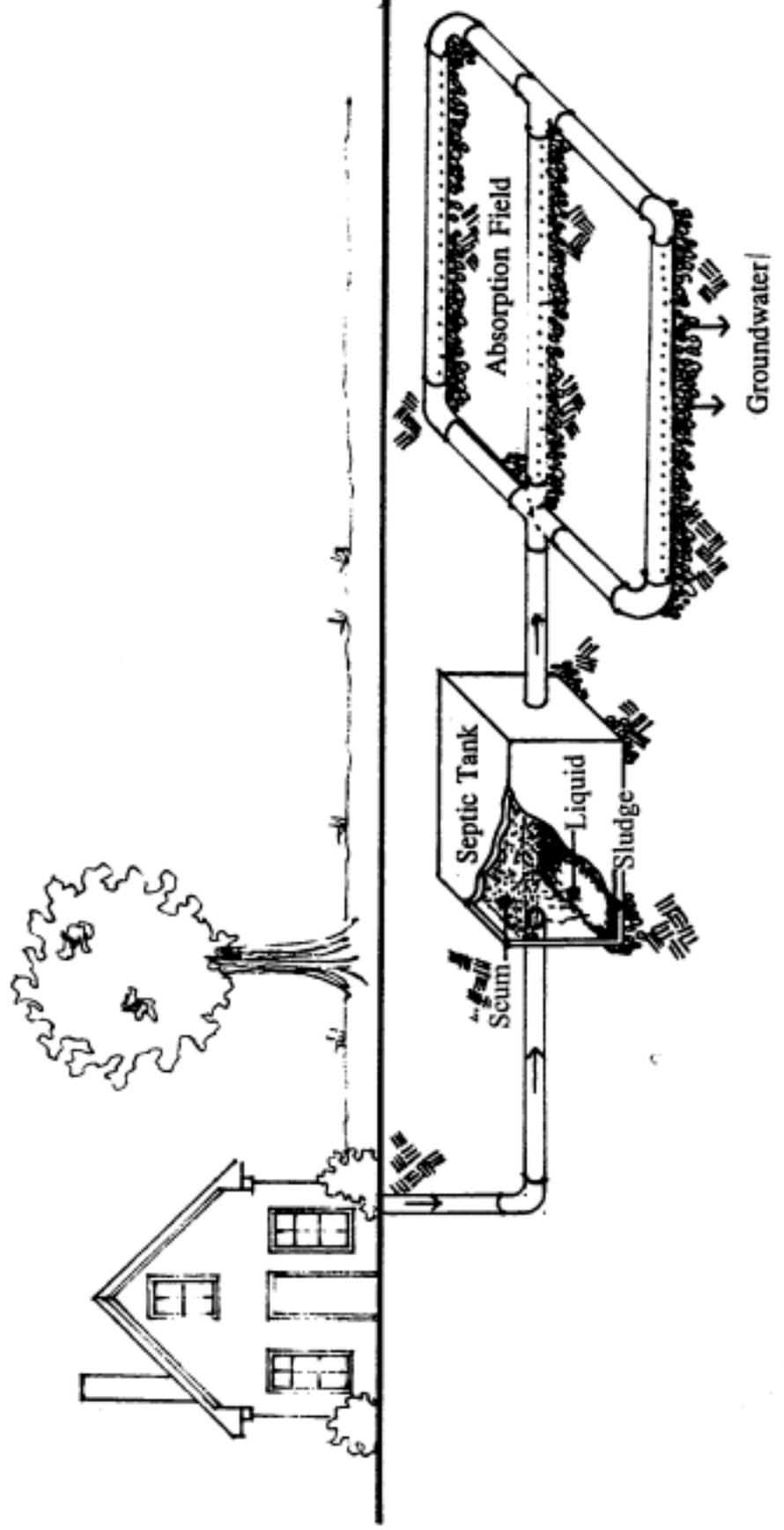


FIGURE 6.2: A Septic System



FACT SHEET: The Treatment of Wastewater

Interesting facts to remember about the treatment of wastewater.

1. The water that we have used in factories and homes is called **wastewater**; it must be recycled back to the environment.
2. To keep our water resources clean, it is our responsibility to treat and clean **wastewater** before returning it to the environment.
3. Homes and factories connected to public water systems usually send their used water through sewer lines to **wastewater treatment plants**.
4. **Septic systems** are used by homes which do not have access to public wastewater systems.
5. **Wastewater** is also known as **sewage**.
6. The purpose of a **wastewater treatment plant** is to clean up water before releasing it back to the environment.
7. There are typically three steps in which wastewater is treated in a treatment plant: **primary, secondary, and tertiary treatment**.
8. The main purpose of the **primary treatment** process of water treatment is to remove solid materials.
9. The **secondary treatment** process uses biological methods, such as the use of microorganisms, to help clean wastewater.
10. Sometimes a third step, called **tertiary treatment**, is used in water treatment plants; in this step the water may be treated with chemicals, filtered and then chlorine added.
11. Large amounts of **sludge** are left behind after treating wastewater.
12. **Sludge** is rich in **nutrients** and can be used as plant fertilizer.
13. **Septic systems** have two main parts: a **septic tank** and the **absorption field**.
14. It is important to properly maintain septic systems to keep them working properly.
15. By properly maintaining our wastewater treatment plants and septic systems, we contribute to good water quality in the water we recycle to the environment.

GLOSSARY: The Treatment of Wastewater

absorption field	That part of a septic system usually made up of perforated pipes; these allow wastewater to drain into the soil for its final treatment.
aeration	The process of adding air to water; this increases biological activity.
cake	Dried sludge material from wastewater; it can be used as fertilizer.
digest	To break down material (such as sludge) into smaller parts; this may be done by bacteria in wastewater and soils.
disinfect	To kill microorganisms, to clean; one method is to use chlorine.
grit	Materials such as sand and gravel which are removed from wastewater in the first step called primary treatment.
hydrologic cycle	The process by which water is recycled by precipitation, evaporation, transpiration and condensation.
impurities	Substances which, when present, make another substance not pure or clean.
landfill	A disposal site beneath the land surface for solid waste products generated by people; the wastes are packed and covered with earth.
microorganism	An organism that can only be seen by a microscope, such as a bacteria; bacteria aid in wastewater treatment.
nutrients	Chemical elements necessary for good plant growth and health.
oxygen	A chemical element that is present in air.
perforated	Something which has been pierced by holes, such as the pipes in an absorption field of a septic system.

primary treatment	The first stage of treatment in a wastewater treatment plant in which large pieces of material are removed.
scum	The layer of fats, oils and other materials that float on the liquid in a septic tank.
secondary treatment	The second stage of treatment in a wastewater treatment plant which removes wastes primarily by bacterial action.
sedimentation tank	The tank in a wastewater treatment plant where solid material settles out from wastewater to the bottom of the tank; there are typically two of these tanks in the treatment process: a <i>primary</i> and a <i>secondary</i> sedimentation tank.
septic system	A wastewater disposal system, used by homes not connected to public systems; it usually consists of a septic tank and absorption field.
septic tank	The part of a septic system to which wastewater flows from a house; it is a watertight box buried underground.
sewage	Another name for wastewater.
Sludge	Solid waste material which settles out during wastewater treatment; after it is treated, it may be used as fertilizer.
tertiary treatment	The third stage in a wastewater treatment plant which is sometimes used to remove even more impurities from wastewater.
wastewater	Water which has been used by people in homes, businesses, farms or factories; it carries solid and dissolved impurities.
wastewater treatment plant	A plant which treats wastewater to remove contaminants so that the water can be safely released back to the environment.

WORKSHEET 6.1: Definitions

Directions: In the left column are definitions to the *Words to Remember* and in the right column are the words. Match the words with the correct definitions. Place the letter of the correct definition in the blank to the left of the word.

-
- | | |
|---|-------------------------------|
| _____ 1. Another name for wastewater. | A. absorption field |
| _____ 2. A wastewater disposal system, used by homes not connected to public systems; it usually consists of a septic tank and absorption field. | B. aeration |
| _____ 3. To kill microorganisms, to clean; one method is to use chlorine. | C. cake |
| _____ 4. That part of a septic system usually made up of perforated pipes; these allow wastewater to drain into the soil for its final treatment. | D. digest |
| _____ 5. The process of adding air to water; this increases biological activity. | E. disinfect |
| _____ 6. A plant which treats wastewater to remove contaminants, so that the water can be safely released back to the environment. | F. grit |
| _____ 7. The part of a septic system to which wastewater flows from a house; it is a watertight box buried underground. | G. hydrologic cycle |
| _____ 8. Materials such as sand and gravel which are removed from wastewater in the first step called primary treatment. | H. impurities |
| _____ 9. The second stage of treatment in a wastewater treatment plant which removes wastes primarily by bacterial action. | I. landfill |
| _____ 10. To break down material (such as sludge) into smaller parts; this may be done by bacteria in wastewater and soils. | J. microorganism |
| _____ 11. Water which has been used by people in homes, businesses, farms or factories; it carries solid and dissolved impurities. | K. nutrients |
| | L. oxygen |
| | M. perforated |
| | N. primary treatment |
| | O. scum |
| | P. secondary treatment |
| | Q. sedimentation tank |
| | R. septic system |
| | S. septic tank |
| | T. sewage |
| | U. sludge |
| | V. tertiary treatment |
| | W. wastewater |
| | X. wastewater treatment plant |

- _____12. The third stage in a wastewater treatment plant which is sometimes used to remove even more impurities from wastewater.
- _____13. Something which has been pierced by holes; such as the pipes in an absorption field of a septic system.
- _____14. The first stage of treatment in a wastewater treatment plant in which large pieces of material are removed.
- _____15. Solid waste material which settles out during wastewater treatment; after it is treated, it may be used as fertilizer.
- _____16. The tank in a wastewater treatment plant where solid organic material settles out from wastewater to the bottom of the tank; typically there are two of these: a *primary* and a *secondary* tank.
- _____17. Dried sludge material from wastewater; it can be used as fertilizer.
- _____18. An organism that can only be seen by a microscope, such as a bacteria.
- _____19. A chemical element that is present in air.
- _____20. The process by which water is recycled by precipitation, evaporation, transpiration and condensation.
- _____21. Chemical elements necessary for good plant growth and health.
- _____22. Substances which, when present, make another substance not pure or clean.
- _____23. The layer of fats, oils and other materials that float on the liquid in a septic tank.
- _____24. A disposal site beneath the land surface for solid waste products generated by people; the wastes are packed and covered with earth.

WORKSHEET 6.2: Vocabulary

P Y S R H M V D G R I T K L P E Q S X C H
R K I T W X Q U S X L P N I R S P D H H K
I T L E N T N Y S W O R A V B T E A J L L
M E S E W A G E M S F R T O T N E R Z O E
A R T V M E T N O T E D N S C E D U T R N
R U D A S R I U V T B W O R L I I E W I A
Y X P W F A E R L O P O I W T R S E T N L
T W R S J T R I E L D I T C S T I A M E O
R E C C M I F C V F O W A B D U N U S O S
E D K B X O A B S O R P T I O N F I E L D
A A Y R W N A R I N E D N C V N E M P L Q
T R E F D C E E J G V V E S A N C M T P U
M I R N T I R O G E N X M T S E T U I E R
E O Q E A S A R I D C V I W A R N X C N E
N P R K N Z E F T E U C D A X U F E T M S
T I C M F N M E I O P L E W S J A N A Q K
A W A S T E W A T E R D S Y T R E W N R T
Z E D S I M O P E F R I L O S C A S K A N

Directions: Identify the words to the definitions and find in the Wordsearch above.

1. The process of adding air to water. _____
2. The area of a septic system which is supplied by perforated pipes.

3. A one-celled organism. _____
4. A chemical used to disinfect or kill organisms. _____
5. To kill unwanted organisms by using chlorine. _____
6. To remove pieces of material by screens or other devices. _____
7. Material such as sand and gravel which is removed from wastewater. _____
8. Chemical elements necessary for good plant growth and health. _____
9. Substances which harm the quality of air, land or water. _____
10. The first stage of treatment in a wastewater treatment plant in which large pieces of material are removed. _____
11. The tank in a wastewater treatment plant where solid organic material settles out from wastewater to the bottom of the tank. _____
12. A watertight box which is part of a septic system. _____
13. Another name for wastewater. _____
14. Material which settles out of a water treatment process; it is high in nutrients and is sometimes used as fertilizer. _____
15. Water which has been used by people and factories; it must be cleaned before returning it to the environment. _____

WORKSHEET 6.3: Facts about the Treatment of Wastewater

Directions: Below are sentences with words missing. Write the letter of the best answer in the blank. You may use the *Background Information* to help you.

1. Wastewater is produced by _____.
 - A. factories and businesses
 - B. homes
 - C. farms
 - D. all of the above

2. The two methods for *completely* treating wastewater are _____.
 - A. aeration and settling tanks
 - B. wastewater treatment plants and septic systems
 - C. absorption fields and grit chambers
 - D. rivers and oceans

3. Used water from _____ sources are cleaned by wastewater treatment plants.
 - A. public
 - B. private
 - C. public and private
 - D. septic system

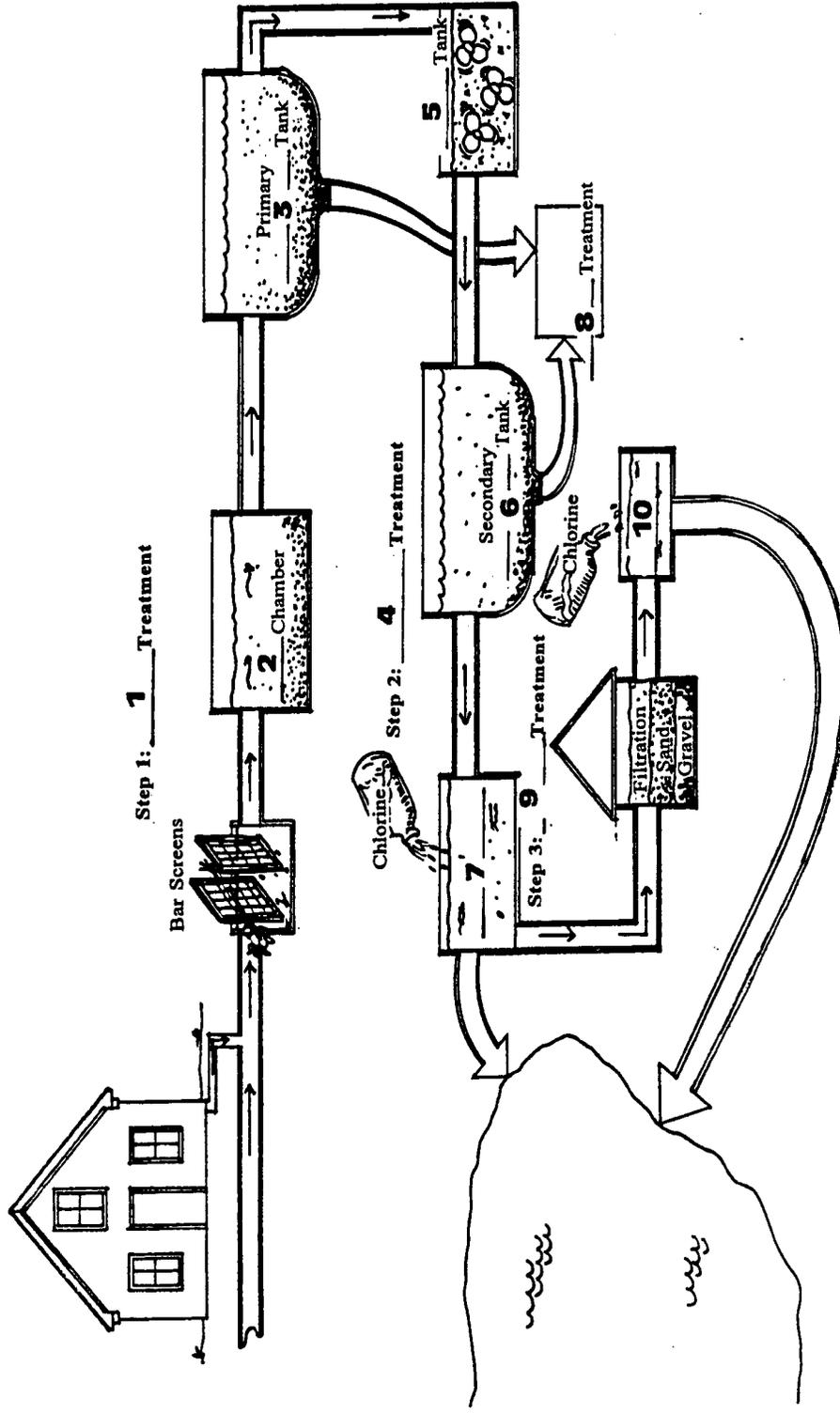
4. The primary treatment step in wastewater treatment plants uses _____ to help remove solid materials from wastewater.
 - A. aeration
 - B. screens
 - C. chlorine
 - D. digestion

5. Aeration is produced by adding _____ to help speed up bacterial growth.
 - A. oxygen
 - B. chlorine
 - C. bacteria
 - D. sludge

6. The _____ treatment step sometimes uses beds of sand to remove additional solids from wastewater; this step is not always used.
- A. primary
 - B. secondary
 - C. tertiary
 - D. none of the above
7. _____ is the name of the solid material produced by wastewater treatment; when it is dried to form **cake**, it can be re-used as fertilizer.
- A. Sewage
 - B. Grit
 - C. Grease
 - D. Sludge
8. Septic systems have 2 main parts: a septic tank and a(n) _____.
- A. absorption field
 - B. aeration tank
 - C. sedimentation tank
 - D. grit chamber
9. _____ in the soil help digest material in the absorption field.
- A. Gravel
 - B. Chlorine
 - C. Microorganisms
 - D. Sludge
10. Septic systems should be maintained by _____.
- A. the Public Health Department
 - B. private homeowners
 - C. the Water Works Department
 - D. the local government

WORKSHEET 6.4: The Process of Treating Wastewater

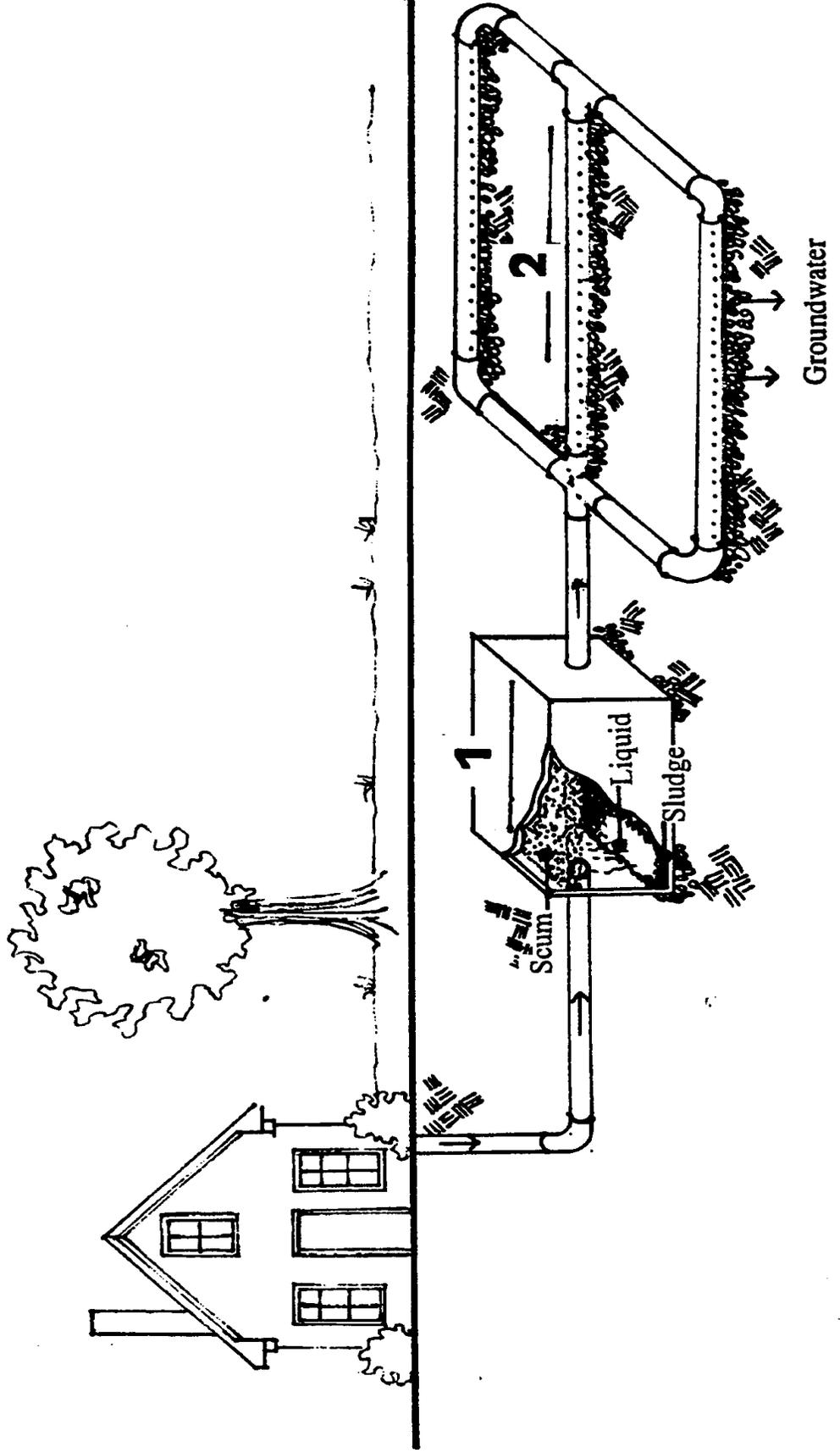
Directions: Write the name for the process of wastewater treatment next to the appropriate number.



1. _____ treatment _____ tank
2. _____ chamber _____ tank
3. primary _____ treatment _____ tank
4. _____ treatment _____ tank
5. _____ treatment _____ tank
6. secondary _____ treatment _____ tank
7. _____ treatment _____ tank
8. _____ treatment _____ tank
9. _____ treatment _____ tank
10. _____ treatment _____ tank

WORKSHEET 6.5: A Septic System

Directions: Write the name for the 2 main parts of the septic system next to the appropriate number.



ACTIVITY 6.1: Investigation of Local Wastewater Treatment Facility

Goal:

To understand how the local wastewater treatment facility operates.

Objective:

- To compare the local wastewater treatment facility with a standard wastewater treatment facility.

Materials:

- Handout: "Wastewater Treatment Plant Questionnaire"

Procedure:

1. Arrange to take the students on a field trip to the local wastewater treatment plant.
2. Ask someone at the local wastewater treatment plant to give students a tour, so they will be able to see first hand the different stages of water treatment. Be sure to plan for enough time for questions.
3. Give each student a copy of the questionnaire. Encourage students to be observant, ask questions, and record information needed for completing the questionnaire.
4. After the field trip, ask students to compare their observations and then share all information that was gathered with the whole group.
5. Because there are differences in various processes between wastewater treatment facilities, ask the students to compare the way your community treats wastewater with the diagram of a wastewater treatment plant in this unit.

community. By interviewing plant personnel, students will have experience in researching their community's methods of treating water. This should make them more informed about their local water supplies and what happens to their own wastewater.

Discussion Questions:

1. What was the most interesting thing you learned about the way your community treats wastewater?
2. How does your treatment facility compare with the one pictured in this unit?

Desired Outcome:

Students will complete questionnaire and will then verbally note the differences between their observations and the diagram.

Evaluation:

1. Students observe the different processes in the plant for treating the water.
2. Students compare the process their local water treatment plant uses with the diagram of a wastewater treatment plant in this unit.

Discussion:

An investigation of your local wastewater treatment plant will increase awareness of water usage in your

Adapted from the poster "How Do We Treat Our Wastewater," used with permission of American Water Resources Association.

ACTIVITY 6.1: Water Treatment Plant Questionnaire

As you tour your local wastewater treatment plant, please answer the following questions.

1. Where is your local wastewater treatment plant located?

2. How many stages of treatment does your facility use?

primary _____ tertiary _____

secondary _____ other _____

3. What is the capacity of the treatment plant?

_____ liters (gallons) per day

4. How is the sludge disposed of?

burned _____ landfill _____

fertilizer _____ other _____

5. Where does the treated wastewater go after it leaves the plant?

river or stream _____ lake _____

ocean _____ other _____

6. In what year was the plant built? _____

7. Have there been any modifications of the plant in recent years?

8. Are there any plans for additional improvements to the plant?

9. Where does the wastewater treatment plant get its money to operate, and how much does it cost to operate the water treatment plant each year?
-

10. Draw a diagram the wastewater treatment facility that you just toured. How is this water treatment facility different from the one that you have just studied about?

ACTIVITY 6.2: Investigation of A Septic System

Goal:

To understand how a septic system process works.

Objective:

○ To list considerations in selecting a site for installing a septic system.

Materials:

- Handout: "Septic Tank System Questionnaire"
- Optional: Borrow the plexiglass **Septic System Model** from one of the Regional offices in Extension (see **Equipment and Materials** under Bibliography and Resource Materials) for more information.

Procedure:

1. Ask a guest speaker to talk to the group about septic systems. Possible speakers include: a representative from a company that pumps out septic systems, someone from the health department or a private homeowner who owns a septic tank.
2. Have the speaker include advantages, disadvantages, and any special precautions to be considered with septic systems.
3. Give each student a copy of the questionnaire. Encourage students to be observant, ask questions, and record information needed for completing the questionnaire. (If student does not have a septic system at home, have them interview someone who has one or pair up with a student who does have one.)
4. After the guest speaker visits, ask students to compare their observations and then share all information that was gathered with the whole group.

Discussion:

An investigation of your own septic system will increase awareness of your wastewater treatment. By interviewing someone at a company who pumps out septic systems, students will have experience in researching their community's methods of treating water. This should make them more aware of the process of properly maintaining a septic tank system.

Discussion Questions:

1. What is the most interesting thing you learned about your septic system?
2. How does your septic system compare with the one pictured in this unit?
3. How does your septic system compare with those of other students? What have been some of the major problems?
4. How helpful was the company who pumps septic systems in giving you information?
5. How many students knew the location of their septic tank and absorption field before this exercise?
6. Try to obtain a copy of your parents' last month's water bill. How does the bill compare between students who have septic systems and those who are connected to a public wastewater treatment system?

Desired Outcome:

Questionnaire will be completed and students will be able to discuss considerations for selecting sites for septic systems.

Evaluation:

Students will be able to discuss factors to consider when deciding to install a septic system. *Adapted from the poster "How Do We Treat Our Wastewater," used with permission of American Water Resources Association.*

ACTIVITY 6.2: Septic Tank System Questionnaire

If your home uses a septic system to treat wastewater, complete the following: (ask for help from your parents)

1. Draw a map of your home and yard on the back of this form or on a separate sheet of paper. Mark the location of your septic tank and the absorption field.
2. When was your septic tank built? _____
3. Have there ever been any problems with the system?
yes _____ no _____

If yes, what was the problem?

4. Is there any special care you must take in your house with your wastewater?

5. How often must your septic system be pumped? _____

6. How much does it cost to have it pumped? _____

7. Where was the pumped waste disposed?

landfill _____ treatment facility _____

lagoon _____ other _____

8. What did you learn when you investigated your home's septic system?

ACTIVITY 6.3: Filtering and Leaching of Used Water

Goal:

To simulate the processes of filtration and leaching¹.

Objective:

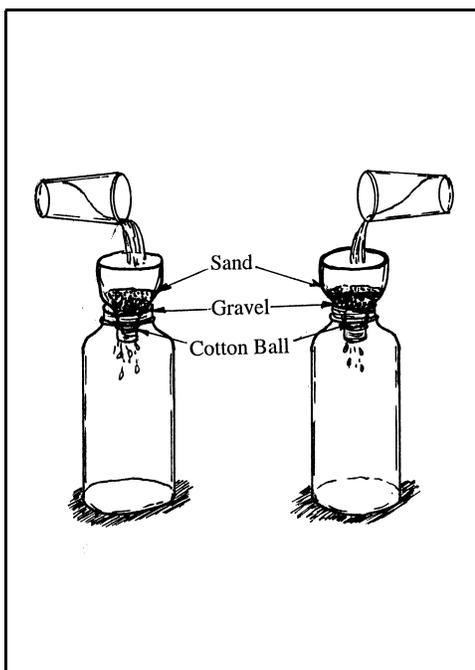
- To differentiate between the natural water filtration process and the leaching process of contaminants and pollutants.
- To apply the simulated leaching process to the drainage of field lines in a septic system.

Materials:^{2,3}

- Empty 2 liter plastic soft drink bottles (with lids)
- Cotton balls
- Small vial of food coloring
- 1/4 cup potting soil
- 3 empty wide-mouthed clear glass or plastic jars (such as peanut butter or pickle jars)—at least one with lid
- Scissors
- Gravel and sand

Procedure:

1. Cut off bottom of soda bottles, discard bottoms.
2. With caps on tops of cut-off bottles, invert and fill both bottles about 1/3 full with cotton balls. (The bottles will serve as funnels).
3. On top of cotton balls, add one layer of gravel and one layer of sand. Leave a couple of inches free at the top of the funnel.
4. Remove caps and place "funnels" on top of jars.
5. Place the potting soil and about 1/2 cup of water into another jar (with lid). Put on jar lid and shake several times to make muddy water.



Teacher Notes:

² Have enough materials for each pair of students to perform the experiment.

³ **CAUTION:** Filtered water in this experiment is not suitable for drinking.

¹ Leach: To wash materials away from or into the earth.

6. Slowly pour the muddy water into one "funnel." Water should come out clear.
7. Drop several drops of food coloring into the second "funnel."
8. Pour about 1/2 cup of **clean** water into this funnel. Water should come out colored.

Discussion:

The funnel with gravel and sand represents the composition of soils. When dirty water is poured through these materials, it comes out clean (**see Note 3**) because of a natural filtration process. This experiment demonstrates the ground's natural ability to cleanse water, just as water is cleaned in the absorption field in septic systems. However, when a pollutant (such as demonstrated by the food color) contaminates the soil, the natural filtration process does not cleanse the water. Drinking water supplies can become polluted if a septic system is placed too close to a well.

Discussion Questions:

1. What purpose did the sand and gravel serve?
2. What is this process called when it occurs in nature?
3. When this process occurs naturally, what determines if the water is safe to drink?
4. What is the name of the process when the food coloring was not filtered out of the water?
5. Why is this process dangerous when it occurs in nature?
6. If the soil around an absorption field of a septic system contained wet, clay soils rather than gravel and sand, how would the septic system function?
7. What are some ways in which a septic

system might become contaminated?

Desired Outcome:

The water which is filtered through the first funnel should be clear. The water which comes through the second filter should be colored (this represents pollution).

Evaluation:

1. Students will conduct the experiment accurately so that there is a discernable difference in the two processes.
2. Students will describe how the two processes are different and why leaching is dangerous to our water supply.
3. Students will apply the concepts filtration and leaching to the functioning of properly maintained septic systems.

Activity adapted from "Water Budgets," Water Watchers, used by permission of Massachusetts Water Resources Authority.

Optional Activities:

1. Have the students diagram the wastewater treatment process on posterboard. Offer a prize to the most original and correct poster.
2. View the video "H2O--The Wastewater Treatment Video," available from the Alabama Cooperative Extension Service Media Library. Requests should be sent to 10A Duncan Hall, Auburn University, AL 36849-5634. Faxes only (334) 844-9650. See Order Form in Bibliography and Resource Materials.

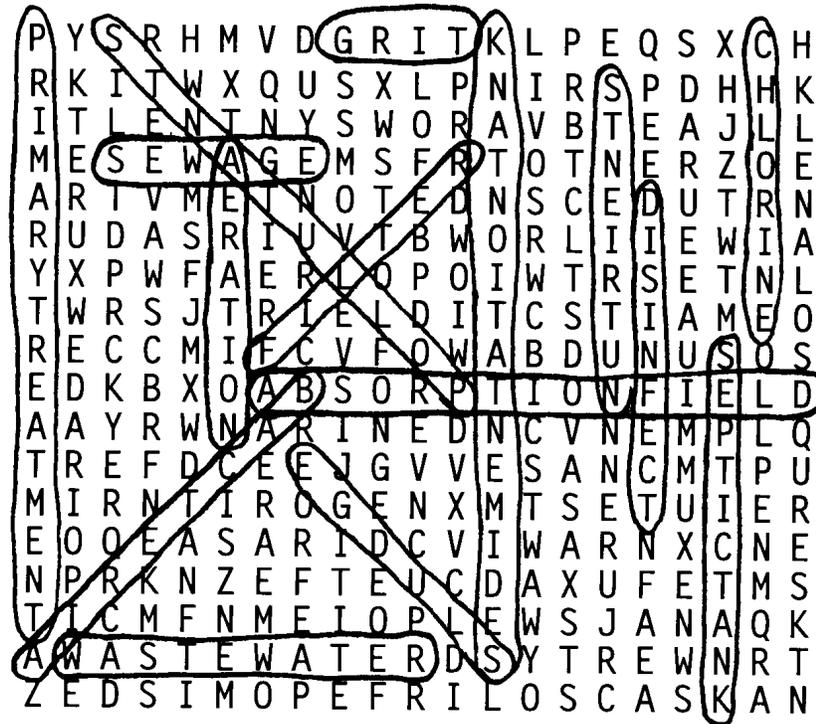
ANSWER KEY
WORKSHEET 6.1: Definitions

Directions: In the left column are definitions to the *Words to Remember* and in the right column are the words. Match the words with the correct definitions. Place the letter of the correct definition in the blank to the left of the word.

-
- | | | | | |
|----------|-----|--|----|----------------------------|
| <u>T</u> | 1. | Another name for wastewater. | A. | absorption field |
| <u>R</u> | 2. | A wastewater disposal system, used by homes not connected to public systems; it usually consists of a septic tank and absorption field. | B. | aeration |
| <u>E</u> | 3. | To kill microorganisms, to clean; one method is to use chlorine. | C. | cake |
| <u>A</u> | 4. | That part of a septic system usually made up of perforated pipes; these allow wastewater to drain into the soil for its final treatment. | D. | digest |
| <u>B</u> | 5. | The process of adding air to water; this increases biological activity. | E. | disinfect |
| <u>X</u> | 6. | A plant which treats wastewater to remove contaminants, so that the water can be safely released back to the environment. | F. | grit |
| <u>S</u> | 7. | The part of a septic system to which wastewater flows from a house; it is a watertight box buried underground. | G. | hydrologic cycle |
| <u>F</u> | 8. | Materials such as sand and gravel which are removed from wastewater in the first step called primary treatment. | H. | impurities |
| <u>P</u> | 9. | The second stage of treatment in a wastewater treatment plant which removes wastes primarily by bacterial action. | I. | landfill |
| <u>D</u> | 10. | To break down material (such as sludge) into smaller parts; this may be done by bacteria in wastewater and soils. | J. | microorganism |
| <u>W</u> | 11. | Water which has been used by people in homes, businesses, farms or factories; it carries solid and dissolved impurities. | K. | nutrients |
| | | | L. | oxygen |
| | | | M. | perforated |
| | | | N. | primary treatment |
| | | | O. | scum |
| | | | P. | secondary treatment |
| | | | Q. | sedimentation tank |
| | | | R. | septic system |
| | | | S. | septic tank |
| | | | T. | sewage |
| | | | U. | sludge |
| | | | V. | tertiary treatment |
| | | | W. | wastewater |
| | | | X. | wastewater treatment plant |

- V 12. The third stage in a wastewater treatment plant which is sometimes used to remove even more impurities from wastewater.
- M 13. Something which has been pierced by holes; such as the pipes in an absorption field of a septic system.
- N 14. The first stage of treatment in a wastewater treatment plant in which large pieces of material are removed.
- U 15. Solid waste material which settles out during wastewater treatment; after it is treated, it may be used as fertilizer.
- Q 16. The tank in a wastewater treatment plant where solid organic material settles out from wastewater to the bottom of the tank; typically there are two of these: a *primary* and a *secondary* tank.
- C 17. Dried sludge material from wastewater; it can be used as fertilizer.
- J 18. An organism that can only be seen by a microscope, such as a bacteria.
- L 19. A chemical element that is present in air.
- G 20. The process by which water is recycled by precipitation, evaporation, transpiration and condensation.
- K 21. Chemical elements necessary for good plant growth and health.
- H 22. Substances which, when present, make another substance not pure or clean.
- O 23. The layer of fats, oils and other materials that float on the liquid in a septic tank.
- I 24. A disposal site beneath the land surface for solid waste products generated by people; the wastes are packed and covered with earth.

ANSWER KEY
WORKSHEET 6.2: Vocabulary



Identify the words to the definitions and find in the Wordsearch above.

1. The process of adding air to water. (**AERATION**)
2. The area of a septic system which is supplied by perforated pipes. (**ABSORPTION FIELD**)
3. A one-celled organism. (**BACTERIA**)
4. A chemical used to disinfect or kill organisms. (**CHLORINE**)
5. To kill unwanted organisms by using chlorine. (**DISINFECT**)
6. To remove pieces of material by screens or other devices. (**FILTER**)
7. Material such as sand and gravel which is removed from wastewater. (**GRIT**)
8. Chemical elements necessary for good plant growth and health. (**NUTRIENTS**)
9. Substances which harm the quality of air, land or water. (**POLLUTANTS**)
10. The first stage of treatment in a wastewater treatment plant in which large pieces of material are removed. (**PRIMARY TREATMENT**)
11. The tank in a wastewater treatment plant where solid organic material settles out from wastewater to the bottom of the tank. (**SEDIMENTATION TANK**)
12. A watertight box which is part of a septic system. (**SEPTIC TANK**)
13. Another name for wastewater. (**SEWAGE**)
14. Material which settles out of a water treatment process; it is high in nutrients and is sometimes used as fertilizer. (**SLUDGE**)
15. Water which has been used by people and factories; it must be cleaned before returning it to the environment. (**WASTEWATER**)

ANSWER KEY
WORKSHEET 6.3: Facts about the Treatment of Wastewater

Directions: Below are sentences with words missing. Write the letter of the best answer in the blank. You may use the *Background Information* to help you.

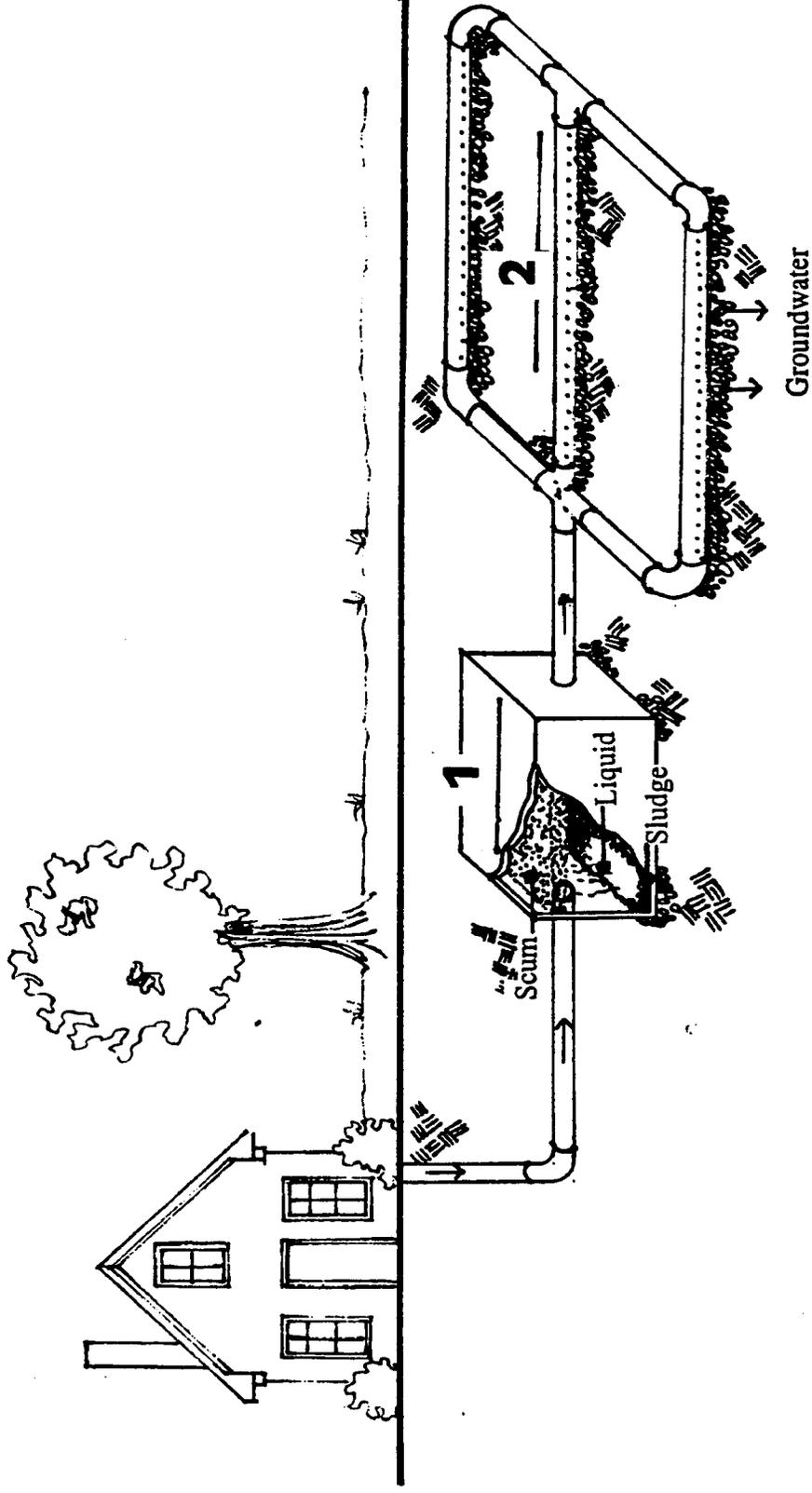
1. Wastewater is produced by **D** .
 - A. factories and businesses
 - B. homes
 - C. farms
 - D. all of the above
2. The two methods for *completely* treating wastewater are **B** .
 - A. aeration and settling tanks
 - B. wastewater treatment plants and septic systems
 - C. absorption fields and grit chambers
 - D. rivers and oceans
3. Used water from **A** sources are cleaned by wastewater treatment plants.
 - A. public
 - B. private
 - C. public and private
 - D. septic system
4. The primary treatment step in wastewater treatment plants uses **B** to help remove solid materials from wastewater.
 - A. aeration
 - B. screens
 - C. chlorine
 - D. digestion
5. Aeration is produced by adding **A** to help speed up bacterial growth.
 - A. oxygen
 - B. chlorine
 - C. bacteria
 - D. sludge

6. The **C** treatment step sometimes uses beds of sand to remove additional solids from wastewater; this step is not always used.
- A. primary
 - B. secondary
 - C. tertiary
 - D. none of the above
7. **D** is the name of the solid material produced by wastewater treatment; when it is dried to form **cake**, it can be re-used as fertilizer.
- A. Sewage
 - B. Grit
 - C. Grease
 - D. Sludge
8. Septic systems have 2 main parts: a septic tank and a(n) **A**
- A. absorption field
 - B. aeration tank
 - C. sedimentation tank
 - D. grit chamber
9. **C** in the soil help digest material in the absorption field.
- A. Gravel
 - B. Chlorine
 - C. Microorganisms
 - D. Sludge
10. Septic systems should be maintained by **B** .
- A. the Public Health Department
 - B. private homeowners
 - C. the Water Works Department
 - D. the local government

ANSWER KEY

WORKSHEET 6.5: A Septic System

Directions: Write the name for the 2 main parts of the septic system next to the appropriate number.



1. _____ SEPTIC TANK

2. _____ ABSORPTION FIELD

HOW AM I DOING?

<u>Page</u>	<u>Yes</u>	<u>No</u>	<u>Date</u>
6-3 Practice reading and saying Words to Remember	_____	_____	_____
6-5 Answer Questions for Review	_____	_____	_____
6-5 Answer Questions for Thought	_____	_____	_____
6-9 Read Fact Sheet	_____	_____	_____
6-10 Review Glossary	_____	_____	_____
	<u>Possible Score</u>	<u>My Score</u>	<u>Date</u>
6-12 Worksheet 6.1: Definitions	<u>24</u>	_____	_____
6-14 Worksheet 6.2: Vocabulary (Word Search)	<u>15</u>	_____	_____
6-15 Worksheet 6.3: Facts About The Treatment of Wastewater	<u>10</u>	_____	_____
6-17 Worksheet 6.4: A Wastewater Treatment Plant	<u>10</u>	_____	_____
6-18 Worksheet 6.5: A Septic System	<u>2</u>	_____	_____
	<u>Complete</u>	<u>In-Complete</u>	<u>Date</u>
6-19 Activity 6.1: Investigation of Local Wastewater Treatment Facility	_____	_____	_____
6-22 Activity 6.2: Investigation of a Septic System	_____	_____	_____
6-24 Activity 6.3: Filtering and Leaching of Used Water	_____	_____	_____