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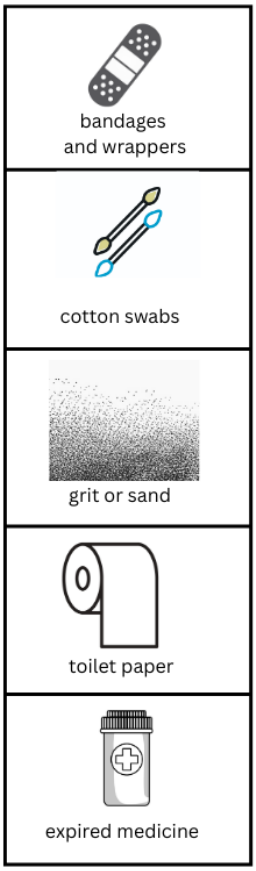
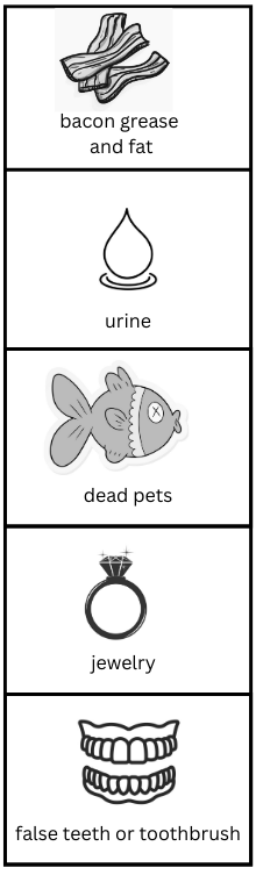
Name _____

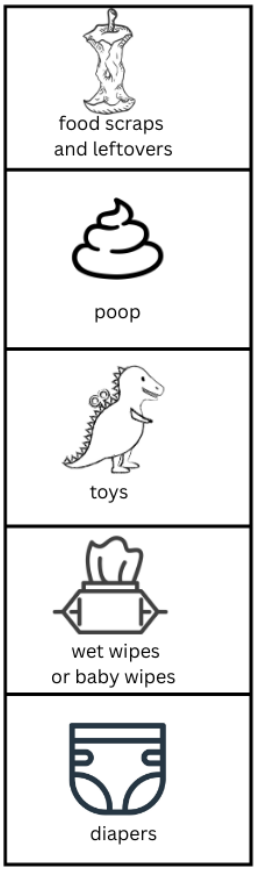
Date _____

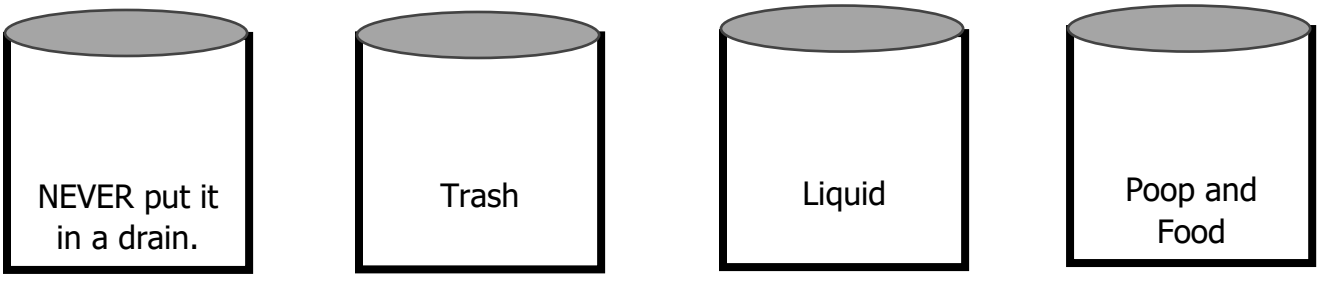
WASTEWATER SORTING ACTIVITY

Research Part I: Wastewater is often sorted into three categories, "Trash," "Liquid," and "Poop and Food." Draw a line to sort these items into the pipe where they belong. Answers may vary. Be prepared to give reasons for your choices.









Pair and Share: Find a partner to compare your answers. Share your findings with the class.

Name _____

Research Part II: Watch *Let's Find Out: How to Clean Wastewater* using this page.

Vocabulary Words: Before watching the movie, review the given definitions. Define the remaining vocabulary words as you watch.

- **Sewer water** [0:19] Sewer water is what goes down the drains in our homes and ends up down at the wastewater plant where it is cleaned.
- **Pretreatment** [0:50]
- **Primary clarifiers** [1:19]
- **Digesters** [1:50]
- **Sludge** [1:50]
- **Compost** [2:00] is fertilizer for plants that can be made from decayed plants, animals, and manure (poop).
- **Methane gas** [2:10] A colorless, odorless gas that burns to make heat and light.
- **Aeration basins** [2:34]
- **Activated Sludge** [3:15] is poopy water with added microbes from river ecosystem.
- **UV sterilization** [5:34]

List at least four drains in your home that connect to sewer pipes.	How is gravity used to clean wastewater?
Where does the bacteria in your poop come from?	Where do other microbes that clean wastewater come from?

Name _____
Date _____

MAKE A WASTEWATER MODEL

Collect these materials for your group.

To make the toilet:

- One small paper cup of water (about 3 oz) labeled "Toilet Tank"
- One clear plastic cup labeled "Toilet Bowl"
- One spoon to create the flush

To fill your toilet bowl:

- ½ Cotton ball to represent diaper
- ½ inch square of wet wipe
- 1 tsp of oil or butter
- 1 inch square of bread (food scraps)
- ½ square of toilet paper
- Pipette or dropper and yellow water (pretend urine)
- 1 tbsp clay coated cat litter (or dirt)
- 1 inch ball of Play doh to represent poop (to be shaped into smaller poop pieces)
- Several pieces of a plastic straw (trash like wrappers, toys, etc.)
- Water for toilet tank

To separate your wastewater:

- 3 small paper cups (about 3 oz). Label one "Trash," one "Liquid," and one "Sludge (poop and food)."

Other materials to clean your water might include wooden coffee stirrers, more cups, tape, paper towels, clay, etc.

Materials

Read the instructions carefully to make realistic wastewater.

Pre-Flush

Notice that there is one tank of water already in the toilet bowl, and another tank ready to flush.

Directions:

Step 1: Decide who in your group will complete the tasks for Toilet Assembler, Toilet Water Keeper, Toilet Filler, and Toilet Stirrer. Your teacher will provide descriptions for these jobs.

Step 2: Before you flush, predict what you expect to see after the flush when the water slows down at the wastewater plant? Will the ingredients stay mixed up or not?

Step 3: Follow your teacher's instructions to fill the toilet and prepare for the flush. Go over the checklist to flush. Does your toilet have one tank of water and all the wastewater items in it? Is the toilet bowl held by the Toilet Assembler? Does the Toilet Stirrer have a spoon read? Is there water in the toilet tank so the Toilet Water Keeper can add it during the flush?

Follow your teacher's directions to flush. What do you observe after the water stops?

IV. Design and build a process to sort your wastewater ingredients into "Trash," "Liquid," and "Sludge." The criteria for success are that the ingredients are sorted as effectively as possible and that ingredients do not end up in the wrong cup.

Your design is constrained by what materials are available to use. What has been provided to you? Do you need something else that can easily be obtained?

Describe your design here.

What problems did you encounter?

What did you learn by looking at the process and results of other groups' design.

ANSWER KEY

Name _____

Date _____

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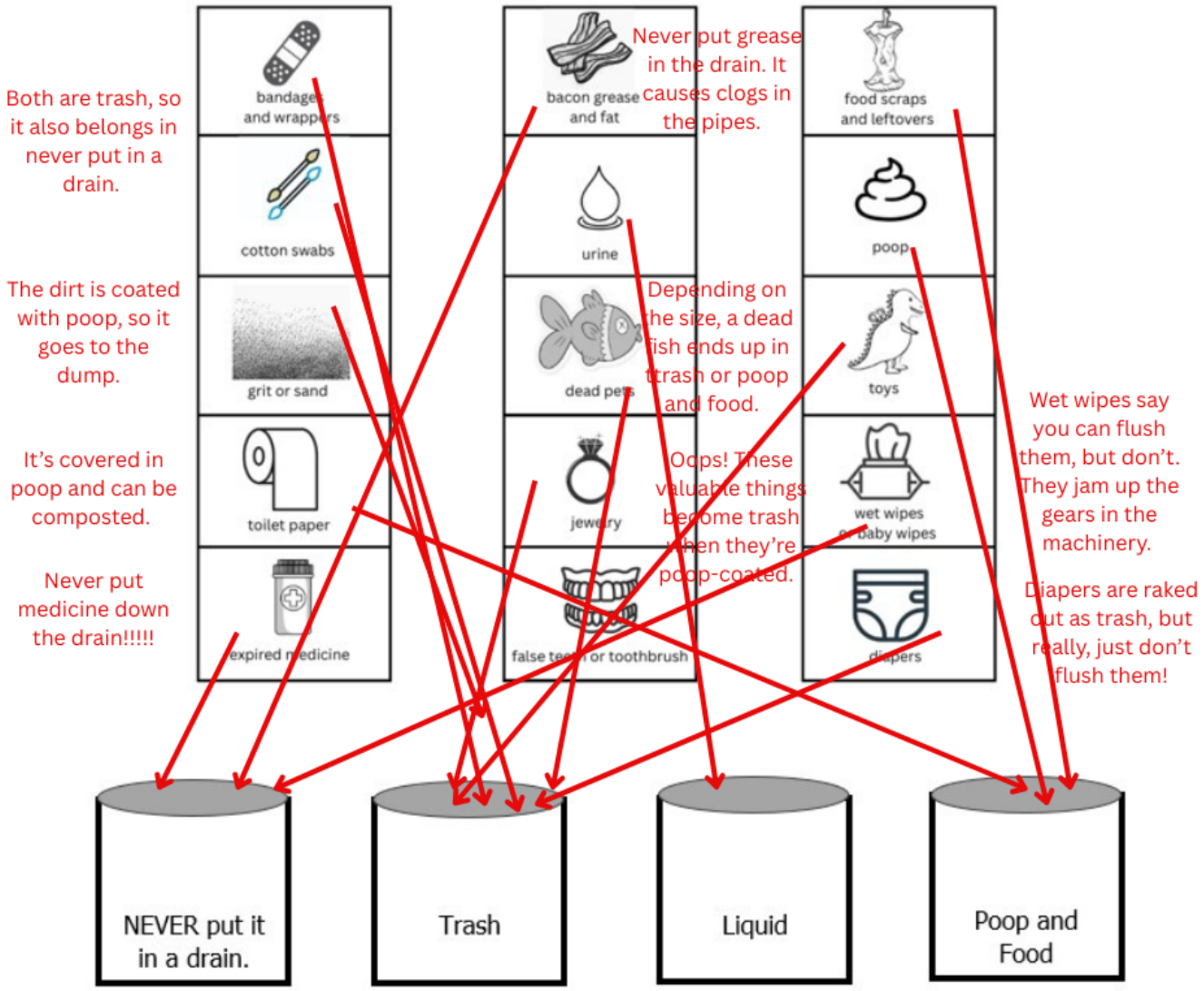
WASTEWATER SORTING ACTIVITY

Research Part I: Wastewater is often sorted into three categories, "Trash," "Liquid," and "Poop and Food." Draw a line to sort these items into a container to be cleaned. Answers may vary. Be prepared to give reasons for your choices.



Pair and Share: Find a partner to compare your answers. Share your findings with the class.

Note: These answers represent one set of answers. Other wastewater plants may sort differently, depending on the machinery they use. Ask students to justify their answers when they their sorting strategy.

Answer Key

Name _____ Date_____

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GUIDE FOR WASTEWATER VIDEO

Vocabulary Words: Review the given definitions. Define the remaining vocabulary words as you watch Let's Find Out: How to Clean Wastewater. https://youtu.be/vV_s0RVXIdg

- **Sewer water** [0:19] Sewer water is what goes down the drains in our homes and ends up down at the wastewater plant where it is cleaned.
- **Pretreatment** [0:50] removes garbage from wastewater. [Note: pretreatment also removes any dirt that entered the wastewater stream through cracks in sewer pipes.]

- **Primary clarifiers** [1:19] are huge basins where wastewater is slowed down so that gravity can work to settle out sludge (poop, bacteria, and undigested food) and fats can be skimmed away.
- **Digesters** [1:50] are huge vats where microbes (bacteria and one-celled organisms) digest the sludge turning it into carbon dioxide and methane gas. [Note: water is also produced.]
- **Sludge** [1:50] is made up of poop, bacteria and undigested food or plant fibers.

- **Compost (a)** [2:00] is fertilizer for plants that can be made from decayed plants, animals, and manure (poop).

- **Methane gas** [2:10] A colorless, odorless gas that burns to make heat and light.

- **Aeration basins** [2:34] are huge vats where the still-dirty water from primary clarifiers is collected so that microbes, some from your guts and some from a river ecosystem, eat the sludge out of the water.
- **Activated Sludge** [3:15] is poopy water with added microbes from river ecosystem.
- **UV sterilization** [5:34] uses ultra-violet light, like the light from the sun that burns your skin. UV light sterilizes the microbes so that they cannot reproduce.

List at least four drains in your home that connect to sewer pipes. Toilets, sinks, showers, tubs, washing machines, dishwashers, garbage disposal	How is gravity used to clean wastewater? When the water is slowed down in clarifiers, it starts dropping heavy things like grit, sludge, etc. Fats rise to the top to be skimmed off
Where does the bacteria in your poop come from? The bacteria in your poop was living in your intestines or guts, helping you digest your food.	Where do other microbes that clean wastewater come from? Microbes that are usually found in rivers or ponds are in the bubbly aeration basins and the swirly basins.

ANSWER KEY FOR WASTEWATER MODEL

This is an example of what students will find. They may need to poke around with the spoon to find the layers. But they should be able to see that the dirt goes to the bottom because it is the heaviest (or most dense). Some poop will be mixed in with the sand, but lots of the poop is layered on top of the sand. The trash like the diaper, baby wipe and toilet paper are probably on top of the poop. The oil (or butter) and plastic rises to the top because it is less dense. This is the basis of the wastewater plant's process that separate sludge and fats from the water. It works like this.

- **Water is slowed so the heavy dirt settles out in grit chamber. (Not shown in movie)**
- **Trash is raked out. (At our plant, the dirt and fats also end up in trash.)**
- **Sludge made of poop and food settles out and is sent to digesters.**
- **Water is sent to basins where microbes consume and digest it. This is also where the final steps occur that break down urea from urine.**
- **Water is settled again to remove microbes and any sludge still in the water.**
- **UV sterilization.**

Students may design a process that is very different from this, or they may try to replicate this process using the materials you provide, such as more cups, coffee stirrers, clay, paper towels or cheesecloth etc. In the end, students should have a cup of trash (including the sand), a cup of sludge and a cup of liquid.

Post-Flush

How would you describe the wastewater now?

Ask groups to observe each of the other groups' work to see how they solved this problem. What can they learn from seeing other solutions?

TEACHER RESOURCES

NGSS Standards:

Elementary Engineering
3-5-ETS1-1 Engineering Design Define a simple design problem…
3-5-ETS1-2 Engineering Design Generate and compare multiple possible solutions…
3-5-ETS1-3 Engineering Design Plan and carry out fair tests…

Middle School Engineering
MS-ETS1-1 Engineering Design Define the criteria and constraints of a design problem…
MS-ETS1-2 Engineering Design Evaluate competing design solutions…
MS-ETS1-3 Engineering Design Analyze data from tests…

Description of Packet: This four-page packet is made of pages that can be used separately or together.

- **Page 1** is a sorting activity that helps students understand what is in wastewater, so they understand what is entailed with cleaning it.
- **Page 2** is a guide to help them understand vocabulary and simple concepts in the movie, *Let's Find Out: How to Clean Wastewater.* (https://youtu.be/vV_s0RVXIdg)
- **Page 3** gives instruction for an activity that makes a model of wastewater.
- **Page 4** asks students to design and build a process to separate the wastewater they made into trash, liquid, and sludge (poop and food). Constraints are what materials you choose to give them to build the process, such as coffee stirrers, clay, extra cups, spoon, paper towels or cheesecloth. Criteria for success is how effectively the poop is contained in the sludge cup.

PAGE 1 SORTING ACTIVITY

Step 1: Brainstorm. Ask the class to brainstorm what goes down the drains in their home and gets into the sewer pipes. They probably won't think about things like fats and oils or items accidently flushed, so you may need to give hints. If necessary, mention that the worksheet uses the word "poop" for feces. It's funny and not offensive, but you may prefer "feces." Set up expectations right away. Sometimes it helps to just say the word together and let them laugh to get it out of their system.

Step 2: Think. Ask students on their own to draw lines from the items to the box where it belongs: "Never," "Trash," "Liquid," "Poop and Food." Answers will vary. Different plants may have different processes. Tell students that they need to be ready to justify their answers.

Step 3: Pair. Ask students to compare and contrast their answers with a partner, one that you choose or one of their own choosing, whichever you prefer. What do they agree on? What differences do they find?

Step 4: Share. As a whole class, ask students what they put in the "Never" box. Did they realize that medicines should NEVER go down the drain? Why is that? (Because they're difficult to separate from the water and not good for the river plants or animals.) Why might fats also be in that category? (Fats coat the pipes and cause clogs.) What items did partners disagree about. How did they justify their answers. How these things are classified depends on the process used at a particular wastewater plant.

PAGE 2 MOVIE GUIDE *Let's Find Out: How to Clean Wastewater.* (https://youtu.be/vV_s0RVXIdg)
Step 1: Some vocabulary words have been defined and should be discussed before viewing the video. The remaining vocabulary words can be defined as you watch the video. The timestamp next to each word alerts you to where the word is used. Stop the video and replay as many times as needed. If students need help, give definitions from the answer key.
Step 2: Before viewing, read the four questions at the bottom so they can listen for the answers as they view. Afterwards, discuss their answers (given in the answer key).

PAGE 3 WASTEWATER MODEL
This is messy but really fun. Write these four jobs on the board so students can choose which they want to be responsible to do in their group.

- Toilet Assembler – This person goes to get and label the clear cup "toilet bowl," the paper cup "toilet tank," and the spoon. This person holds the toilet bowl during the flush.
- Toilet Water Keeper – This person fills the water tank with water and dumps it into the empty toilet bowl (before it gets filled with items). Fill the tank a second time for the flush. LATER, at teacher's cue, dump the water into the toilet for the flush.
- Toilet Filler – This person goes through buffet line of "items" that go into wastewater.
- Toilet Stirrer – This person stirs the toilet bowl after the flush to simulate the movement of wastewater through sewer pipes.

Step 1: Preparation

- Set up the clear cup, paper cup, and spoon for the toilet assembly in one part of the room. Best to keep this separate to avoid student confusion about what's what.
- In another part of the room, set up the items that will go into the toilet bowl in a line, like a buffet line. One person from each group will go through and add the items to the toilet bowl. You may want to personally hand out the ball of poop to each group, so they can start shaping the poop while they're waiting for the Toilet Filler to go through the line. (Note: Butter is an easier fat to deal with than oil, but oil is more challenging to get out of the water. You choose which to use.)

Step 2: Prediction Ask students what they think will happen after this is all mixed up and then the water stops moving at the wastewater plant. Will it stay mixed up? Discuss.
Step 3: The Flush Add drama to the activity by telling students that you'll be doing the Super Bowl Flush. That's when halftime happens during the Super Bowl and millions of toilets flush at the same time. Go through the checklist for each group to make sure everyone is ready to flush. Checklist:

- Toilet tank has water in it.
- Toilet bowl has items and one tank of water in it.
- Toilet Stirrer has spoon in hand.

Now count down, 3-2-1 FLUSH!
The Toilet Water Keeper adds a tank of water to the toilet bowl. The stirrer stirs.
After stirring for 10 seconds, ask them to stop stirring and put the bowl down.
Wait for 3-5 minutes for the wastewater to settle. Ask students to observe their wastewater model. How would they describe the wastewater now? Was their prediction correct? It should be settling in layers, but they may need to poke around to see the layers.

PAGE 4 ENGINEER A SOLUTION

Step 1: Hand out the three cups to each group and ask them to label one as "Trash," another as "Liquid," and another as "Poop and Food." They are going to try to separate out these components of wastewater into the proper cup. Their criteria for success will be how much poop and food ends up in each of the other cups.

Step 2: The constraints they have are limited to the materials you provide. Students often build a sieve to get the water out first. Be sure you've given them cheesecloth or something to make a sieve, like coffee stirrers and clay. If you used oil, they might use their spoon from the flush to skim it off. Or paper towels that you provide so soak it up.

Step 3: After students complete the separation, let them go around the room to see other groups' work. Then discuss the problems they had. What would they need to make a better process next time?

Step 4: Leave lots of time for cleanup!!!