Educator Guide

Engineering Activity 5: Order Up!: Investigating a Reuse Process

Educator Preview

Activity Snapshot

Learners apply what they learned about water quality to reconfigure a model building to reuse as much water as possible.

Timing | 45 minutes

Get Ready & Team Up	10 min.
A Reuse Process	25 min.
Reflect	10 min.
Total	**45 min.**

Level Up Activities 5–25 min. each

Prep Snapshot*

Prep Time 60 min.

- Space Need: Sink
- Print and assemble handouts.
- Prepare Filter Bases for Activity 6, as noted in Materials & Preparation.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking
- Collaboration

Habits of Mind

- Use systems thinking.

Guiding Question

In what orders can water be reused?

Learners Will Do

Reconfigure the pipes in a model building.

Learners Will Know

Engineers can design processes to solve problems.

Connecting Across Activities

Activity 4: Investigating Filters	Activity 5: Investigating Reuse Process	Activity 6: Create a Process
Last time, learners investigated the ability of various filter materials to remove contaminants from a water sample.	**Today**, learners apply what they learned about water quality to reconfigure a model building to reuse as much water as possible.	**Next time**, learners will work in groups to plan, create, and test a water reuse process.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction, pgs. iii–xxvi. Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/58aebdd3

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) in Prep & Setup Guide (PDF) Examples & Template
- plastic container with lid, 8 oz., with yellow water and charcoal filter from Activity 4
- sample of yellow water with no charcoal from Activity 4
- 4 rolls of painter's tape
- 16 sheets of copy paper
- 40 straws, color 1
- 40 straws, color 2
- 40 straws, color 3
- other long items, such as craft sticks or pencils (optional)
- towels or disposable tablecloths (optional)

For each group of 4

- Engineering Activity 3 How Clean Does It Need to Be? Handout, pgs. 52–53
- Engineering Activity 5 Mapping Water Reuse Handout, pgs. 75–76
  - cups
  - yarn to outline locations in home
  - glue to attach yarn
- 1/2 stick of modeling clay
- 1 pair of scissors
- 2 sheet protectors (optional)

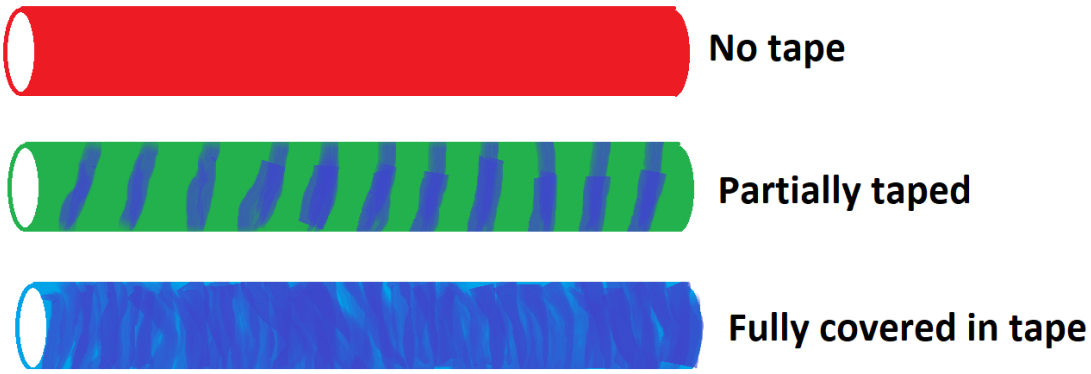
For each learner

- Engineering Notebook (PDF)

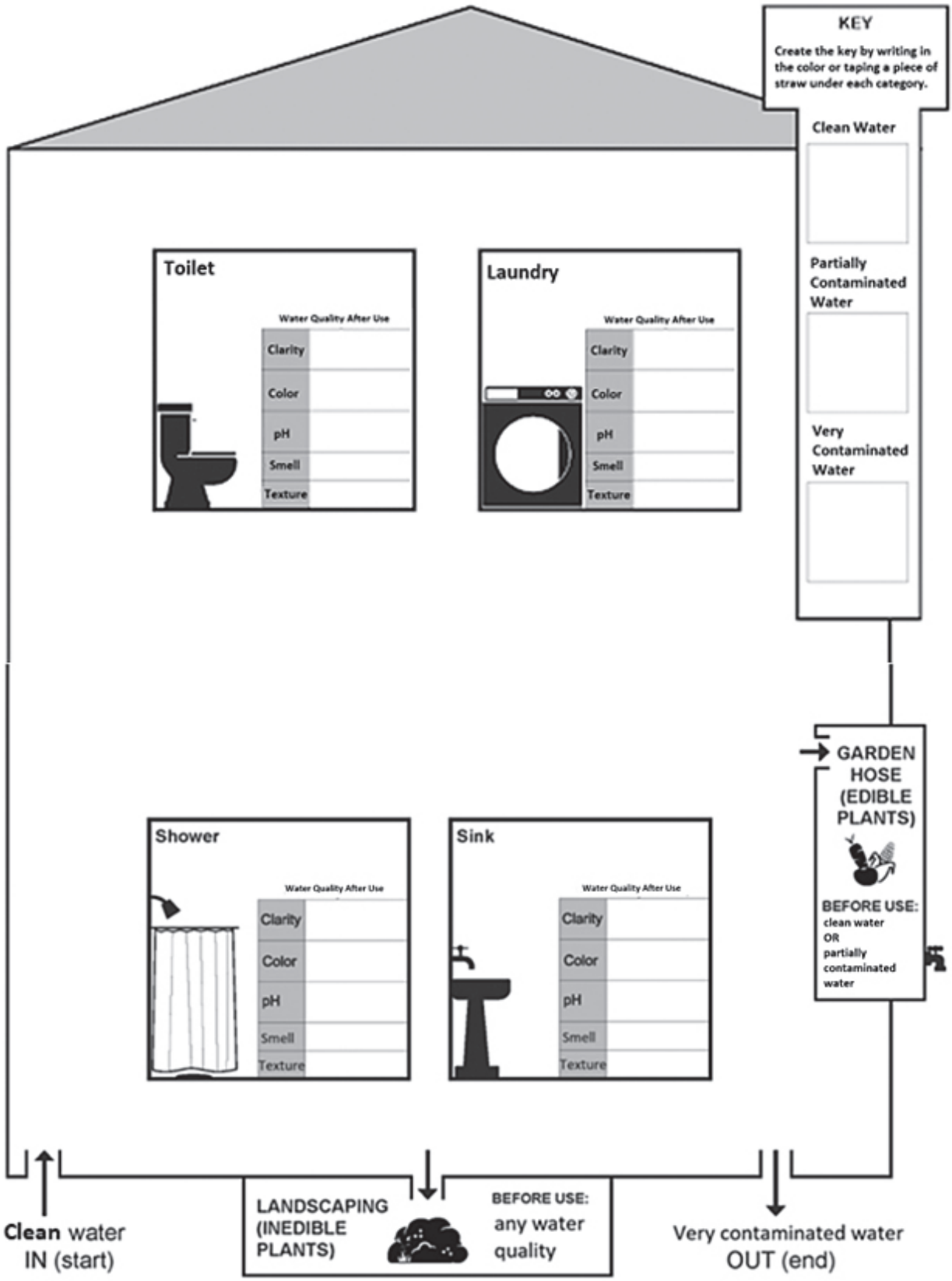
Activity 5 Materials Preparation (60 min.)

Ahead of Time

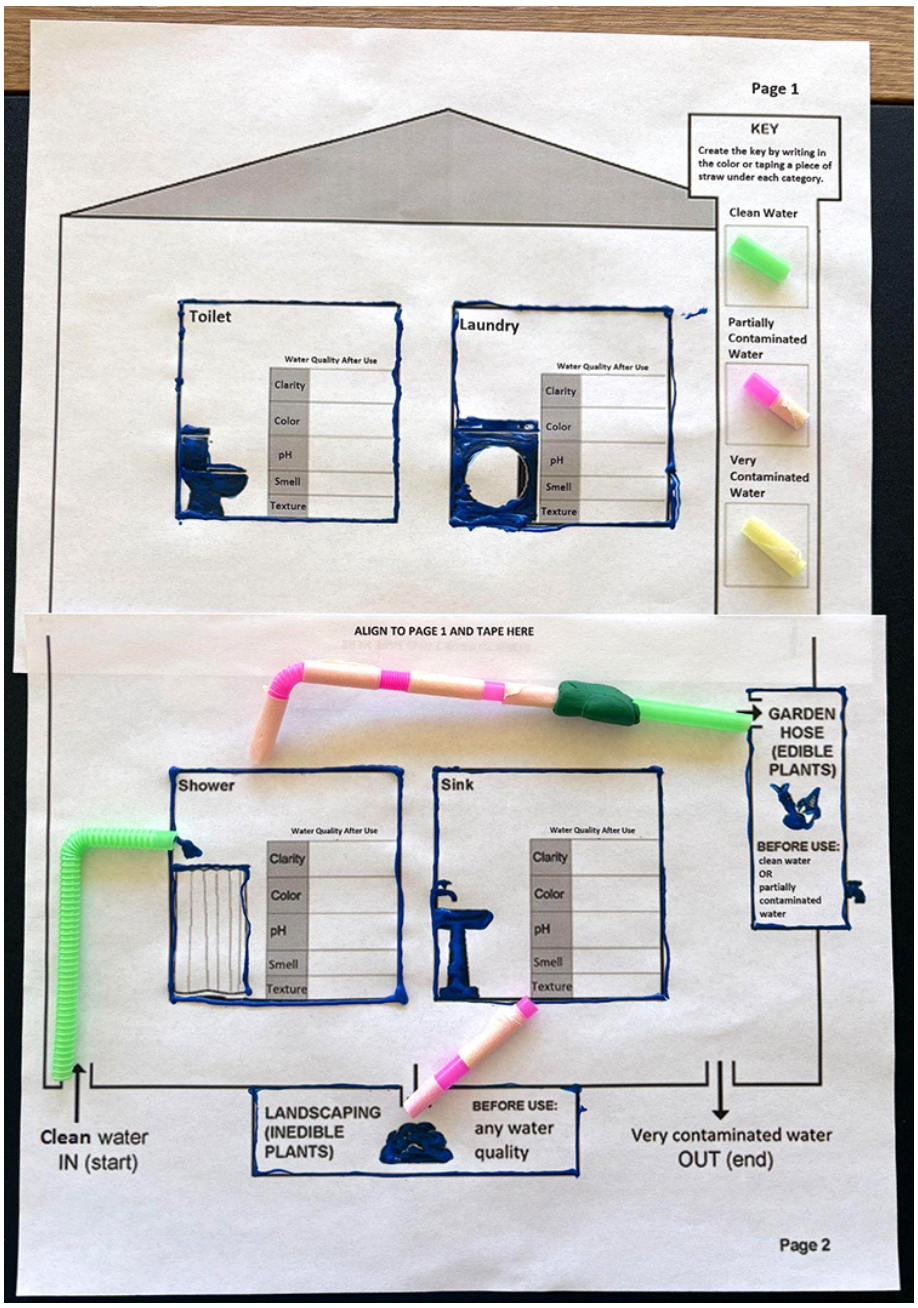
1. Watch the video Engineering How to Part 2 (0:00–1:08) to learn about what happens in this activity.
2. Review the "In-Use Example" in the *Our Ideas* Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this activity.
3. For each group, make copies of both pages of *Engineering Activity 5 Mapping Water Reuse Handout* and tape the two pages together to make one larger sheet for each group (see pgs. 75-76).
4. Fill in the "After Use" water quality sections on the *Engineering Activity 5 Mapping Water Reuse Handout* pages by using learners' data from *Our First Water Sample*, pg. 8 in their Engineering Notebook (PDF).
5. Optional: Glue pieces of yarn to the outlines of the toilet, washing machine, shower, and sink so they can be identified by feel as well as by sight. Attach one cup to each room. Use cups of different materials or cut them to different sizes to make them easy to distinguish for learners who are blind or low vision. (You can also use puff paint or Wikki Stix.)
6. Decide how to make the three kinds of connectors accessible by feel as well as sight. You can
   - Attach intermittent bands of painter's tape to each of the Color 2 straws. Cover the Color 3 straws entirely with painter's tape.



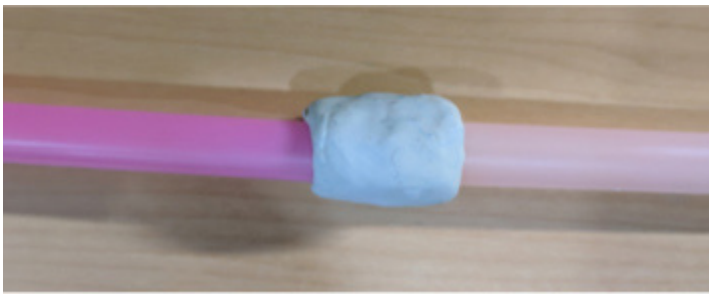
   - Use straws and two other kinds of long items (such as craft sticks and pencils).
7. Make one copy of Engineering Activity 5 Made to Order Handout, pg. 77, for each group.



Mapping Water Reuse Handout pages taped together.



Part of a process is shown on ***Engineering Activity 5 Mapping Water Reuse Handout.***



Modeling clay represents the location of a filter.

In Your Space

8. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally.

Activity 6 Pre-Preparation (15 min.)

Learners will need a total of 12 Filter Bases over the course of this unit (only 6 are needed for Activity 5, but 12 are needed for Activities 6–9). Making Filter Bases can be time consuming, so consider preparing them ahead of time. Follow the Preparing Filter Bases Instructions, pg. 62.

Teaching Tip

Lead this activity in a room with a sink for easy setup.

Activity Guide

Get Ready & Team Up (10 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We investigated how different filter materials can improve water quality in different ways.)* Indicate the word *filter* on the *Our Ideas* poster.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs, xx-xxi) and use other engagement strategies as necessary (pgs, viii–xviii).

2. Ask: **What is the problem we are trying to solve?** *(We are trying to find ways to help people reuse water in places where water is hard to get.)* Show the *Engineering Activity 2 Extreme Environments* slides to remind learners of the locations.
3. Draw learners' attention to the section of the *Our Ideas* poster that describes clean and contaminated water. Say: **One of the problems with very contaminated water is that it cannot be reused as is. However, if it is filtered and its water quality improves, then it can be reused for some purposes.**
   - Make sure to be clear that in a real building, very contaminated water such as sewage must be treated before it can be reused. Simple filters like the ones used in this activity are not sufficient.
4. Say: **In addition to using water for one purpose, engineers design larger systems in which water is used for multiple purposes. Like these engineers, we are going to imagine we are redesigning a building in our community to reuse more water. We will use what we learned about water quality to change the flow of water so it can be reused.** Share the Guiding Question or a similar question from the *Our Ideas* poster with learners aloud and in writing (using multiple languages as needed): **In what orders can water be reused?**
5. Organize learners into groups of four.

A Reuse Process (25 min.)

6. Give each group a copy of *Engineering Activity 5 Made to Order Handout*, pg. 77, to review the challenge. Explain that things your design needs to do are called ***criteria***, and limits on a design are called ***constraints***. Have learners write these words after their definitions on the page, and add them to the *Our Ideas* poster.

Support Learner Differences

To increase learner engagement, you can tell learners they are redesigning a specific building in your community (possibly the building in which you are running the activity or a building they discussed during Activity 2). If your community does not have running water, consider choosing a specific building learners are familiar with elsewhere that would be appropriate to redesign.

Support Thinking

Consider bringing learners to an area where exposed pipes are connected to a sink or toilet.

7. Pass out a taped set of *Engineering Activity 5 Mapping Water Reuse Handout*, pgs. 75–76, to each group. Allow learners to examine the pages. Hold up the items as you explain that they will use straws (or other objects) as model pipes and they will use clay to represent the location of filters (see images in *Materials and Preparation*, pgs. 68-69). They will not be putting water into the straws.

8. Assign one straw color and tape pattern (or one type of object) to indicate each water quality (clean, somewhat contaminated, and very contaminated) and instruct learners to record these colors or patterns on the Key on the first page of the *Engineering Activity 5 Mapping Water Reuse Handout,* pgs. 75–76. Review what these terms mean. Ask: **What is the difference between clean, somewhat contaminated, and very contaminated water?** *(Clean water has the fewest contaminants and can be used anywhere. Somewhat contaminated water has some contaminants and can be used in the toilet and for plants. Very contaminated water has the most contaminants and cannot be used until it is treated.)* Give each group a copy of *Engineering Activity 3 How Clean Does It Need to Be? Handout*, pgs. 52–53, to review the requirements for the different levels of water quality.

9. Pass out a taped set of *Mapping Water Reuse* pages to each group. Have them discuss a plan for the order of water reuse.

10. Let learners gather their materials (straws or other objects, modeling clay, tape, and scissors) and begin designing the ways they will reuse water. They can cut straws and secure them in place with loops of painter's tape placed underneath the straws (make sure the securing tape does not interfere with the texture of other tape on the straws).

11. As groups are working, move around the room and ask: **Why is it important to know the water quality of the samples? How are you choosing an order for the steps to reuse water? In how many locations have you been able to reuse water? Can you think of other ways you could order the water flow?** Record the descriptive vocabulary used by learners, such as *cleaner*, *more contaminated*, *order*, *steps*, and *process* on the *Our Ideas* poster.

Support Learner Differences

- If learners are unfamiliar with the terms *edible* and *inedible*, have them think about plants they can and cannot eat. Explain that plants they can eat are edible and plants they cannot eat are inedible. Have learners give examples of edible and inedible plants in their communities. Note that edible plants become inedible when they are watered with very contaminated water, so it is important to know which plants will be used for food and which will be used for other purposes.
- As needed, provide groups with a tub or other container to hold their materials. Give learners time to examine the materials before they begin designing.

Support Thinking

Encourage groups to be creative with the way they sequence steps in the process. The steps can be arranged in a straight line, branches, or even a loop.

12. Say: **You have been developing a process for reusing water.** Write the word *process* on the *Our Ideas* poster. Ask: **What other processes do you use in your life?** *(Composting food to make soil to grow plants; recycling metal and glass; getting clothes, wearing them, and passing them on for others to use.)* Have learners come up with a definition for the word *process* together and record it on the poster (for example: a series of actions or steps leading to a result or goal.). You can have learners add translations and related images to the poster as well.
13. Bring out the plastic container of yellow water with the charcoal filter and the sample of yellow water with no charcoal. Ask: **What do you notice about the quality of the water now?** *(The water sample is less yellow than it was before.)* Ask: **How can you use this filter material in your water reuse process?** Make sure learners understand that some filters, like charcoal, take time to clean the water.

Reflect (10 min.)

14. Have groups pair up and discuss the Guiding Question: **In what orders can water be reused?** *(Water quality determines the order water can be reused for specific locations. Some locations require cleaner water than others, so a good order uses water at those locations first.).* As needed, remind learners of terms such as *process*, *criteria*, and *constraints* on the *Our Ideas* poster.
15. Ask: **What similarities do you notice between your processes? What differences do you notice? Is the process of reusing water a technology?** *(Yes. It solves the problem of not having enough water by ordering the flow of water so it can be reused.)*
16. Say: **Next time you will begin designing a process for reusing water in one of the four communities we have discussed: the desert Southwest, Mars, a research boat, or the International Space Station.**

Level Up!

- Learners may have questions about when "somewhat contaminated" water is used. Explain that its usage varies depending on the type of contamination, region, local regulations, plant species. Encourage them to look up or ask other learners or educators in your program how such water is used locally. (25 min.)
- Have learners think about the types of contamination astronauts have to deal with on the International Space Station. Would types of contamination be different on the Moon? Or on Mars? (10 min.)
- Ask this story prompt question: **Can you tell a story about a time when you've designed a process for other people to use, or followed a process someone else designed?** *(Possible responses include following a recipe, building something, or following directions.)* Have learners share with a partner (note that the sharing can take forms other than speaking aloud). Consider returning to learners' ideas at the start of the next activity. (20 min.)
- Tell learners, if anyone asks them what they did today, they can tell them "We explored how the order of pipes between locations affects water reuse." (5 min.)
- Give each learner a copy of the Family Connection flyer (PDF) to share at home. (5 min.)
- Refer to the *Engineering Design Process* poster. Ask: **What phases of the Engineering Design Process did you use today?** *(We investigated why order is important; we planned how to order the flow of water; we created a process for reusing water in the home.)* (5 min.)

After the Activity

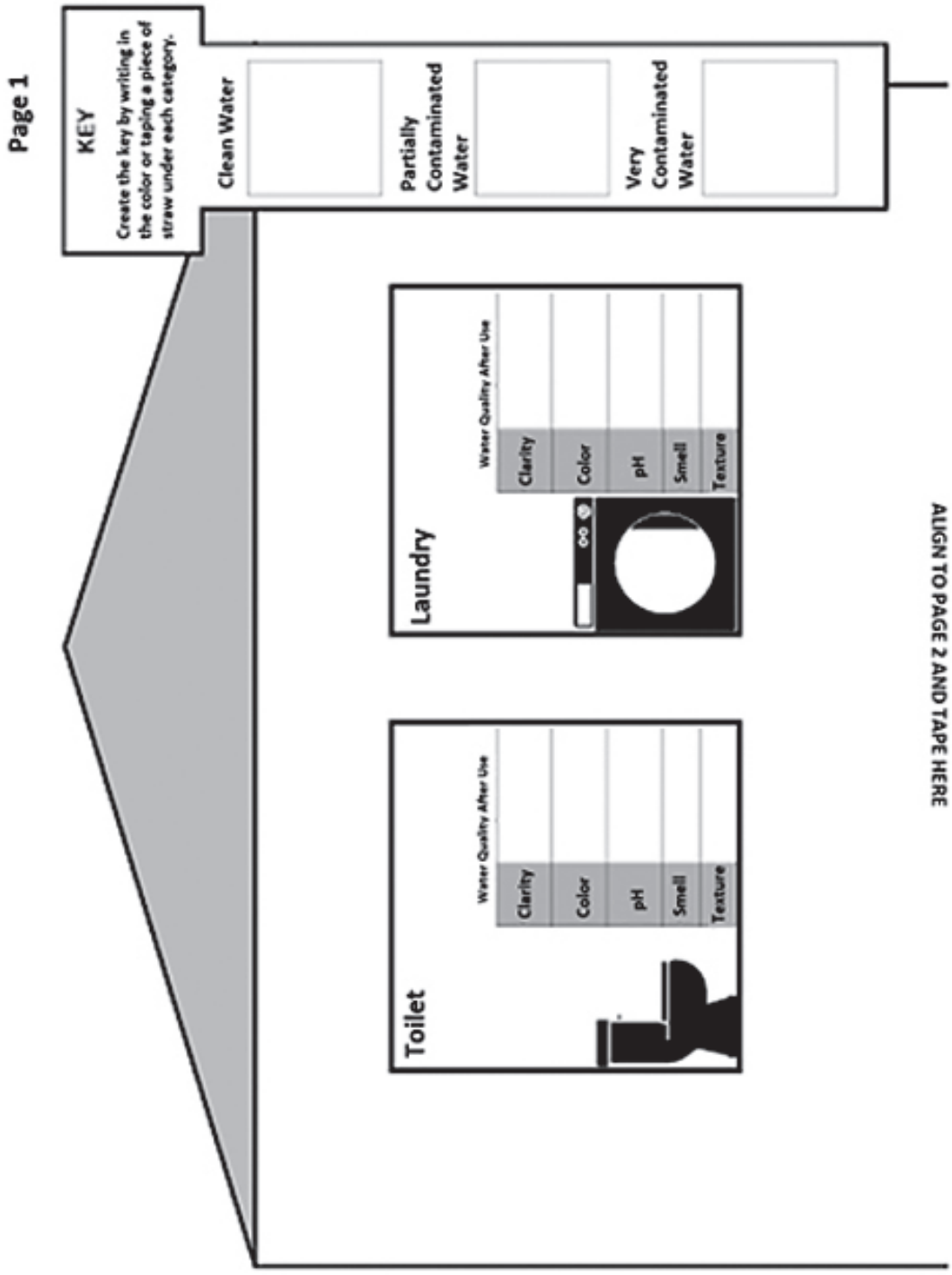
1. Clean up:
   - Save the *Our Ideas* poster for Activity 6.
   - Consider keeping the *Engineering Activity 5 Mapping Water Reuse Handout* pages with processes on them for reference in future activities.
2. Plan for Engineering Activity 6. See Engineering Activity 6 Preparation on pg. 81.
3. Take time to reflect on the following educator prompt. **How did learners demonstrate their understanding of the idea of a process?**

Water in Extreme Environments Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

weblink: https://hov.to/7cb5c428

Mapping Water Reuse



ALIGN TO PAGE 1 AND TAPE HERE
Clean water IN (start)
Shower
Water Quality After Use
Clarity
Color
pH
Smell
Texture
Sink
Water Quality After Use
Clarity
Color
pH
Smell
Texture
LANDSCAPING (INEDIBLE PLANTS)
BEFORE USE: any water quality
GARDEN HOSE (EDIBLE PLANTS)
BEFORE USE: clean water OR partially contaminated water
Very contaminated water OUT (end)
Page 2

Made to Order

We are reconfiguring a building to use less clean water.

Goal

Design a process for reusing water in the building.

Things your design needs to do (criteria)

- Each location must have water going in and coming out.
- Somewhat contaminated water must be used at one or more locations.
- You must represent filters with modeling clay.

Things you have to work with (constraints)

- You will have only five straws of each type and half a stick of modeling clay. (The water will not actually go through the straws.)
- One filter can improve water quality by only one level.
- You cannot reuse toilet water.