What's Wrong in Waterville?

COLLECT EVIDENCE ● ESTABLISH LINKS ● MAKE AN ARGUMENT

Biotechnology Outreach

An exploration in water quality,
experimental design, and implementing solutions
designed for elementary learners.

student name _______________ date _______________

Table of Contents

Investigation

Wrapping Up

Bolded words are defined in the glossary.

BE A SCIENTIST

- ✓ Listen to and read instructions closely
- ✓ Follow all directions, including safety precautions
- ✓ Wear appropriate safety equipment, including medical gloves
- ✓ Collaborate with your team/group to ensure all work is done efficiently and correctly
- ✓ Take time to think about…
  - …WHAT you're doing.
  - …HOW you're supposed to do it.
  - …WHY you're doing it.

Welcome to Waterville!

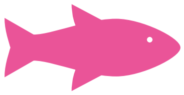
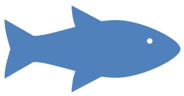
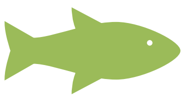
Day 1: Encounter

Students will…

- …use tools to evaluate the health of the fish populations at each pond.
- …analyze the data collected to make an argument about the differences in population quality.
- …begin to question why the ponds might by different.

What ideas/questions do you have? Use this space before, during, and after the activity.

WATERVILLE FISHING MANUAL

Species Photo	Name	Habitat Facts	Average Size
	Rose Fish	Lives in any pond or lake	2 inches
	Blue Gill	Lives best in cleaner water	4 inches
	Green Fin	Lives only in clean water	3 inches

Pond:______________ **Total Fish Caught:**________

Species	Number Caught	<, =, > than average
Rose Fish		
Blue Gill		
Green Fin		

How many were greater than or equal to the average? ______

Workspace:

What is Water Quality?

Day 2: Explain

Students will…

- …analyze water quality data using testing strips.
- …compare and contrast different ponds to identify potential problems.
- …construct an explanation for why Franny's Farm has lower water quality.

What do you know about water quality? Write any ideas, connections, or questions you have before, during, and after the activity.

What do the Waterville scientists say that water quality is?

How can water quality be made better or worse?

	Playful Park	Lively Lake	Secret Spot	Franny's Farm
Nitrate				
pH				
Chlorine				

What could be causing the difference in water quality at Franny's Farm?

What Can We Do?

Day 3: Explore

Students will…

- …brainstorm solutions based on the explanations they made in the previous activity.
- …use a variety of sources to understand how different methods of water purification work.
- …make predictions for how each method would work as a solution for this water quality problem.

How do people keep water clean? Write any ideas, connections, or questions you have before, during, and after the activity.

Location: Playful Park

- Water Quality Improvement Method: ______________________________
- Do you think this would work for Franny's Farm? Why or why not?

____

____

____

____

Location: Lively Lake

- Water Quality Improvement Method: ______________________________
- Do you think this would work for Franny's Farm? Why or why not?

____

____

____

____

Location: Secret Spot

- Water Quality Improvement Method: ______________________________
- Do you think this would work for Franny's Farm? Why or why not?

____

____

____

____

Location: Waterville Lab

- Water Quality Improvement Method: ______________________________
- Do you think this would work for Franny's Farm? Why or why not?

____

____

____

____

Rank each method by how well you think it would work at Franny's Farm.

1. ____
2. ____
3. ____
4. ____

Explain your ranking. Predict what might happen at the pond if Franny used your #1 method.

____

____

____

____

____

____

Why Would It Work?

Day 4: Envision

Students will…

- …learn why hypotheses are important for an experiment.
- …write a formal hypothesis for their experiment.
- …design their experiment and identify variables.

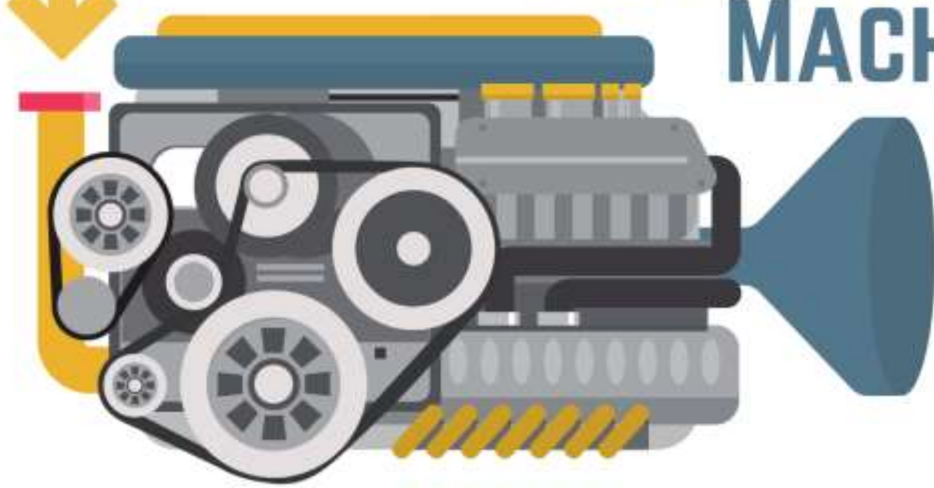
What is a hypothesis? Why are they important? Write any ideas, connections, or questions you have before, during, and after the activity.

NAME: ____________________

Evidence

Reasoning

THE HYPOTHESIS MACHINE



Claim

LAB-O-MATIC

HYPOTHESIS

What is your hypothesis? Which method do you think will work best and why?

PREDICTION

What will the results look like if your hypothesis is supported?

What if it's not supported?

CONSTANTS

What parts of the experiment need to be kept the same?

EXPERIMENT DESIGN

What problem does the experiment solve?

What is being measured, or the **dependent variable**?

What is being changed, or the **independent variable**?

What should we use as a **control**?

Based on Eric Hall and Maureen Griffin's Lab-O-Matic ©2014.

How Do We Test It?

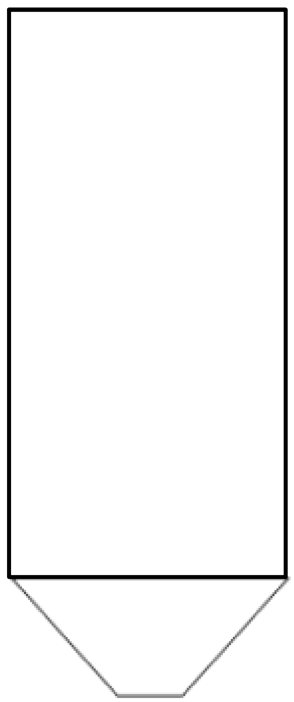
Day 5: Experiment

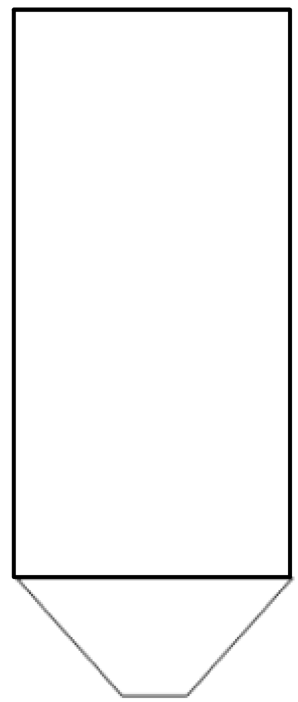
Students will…

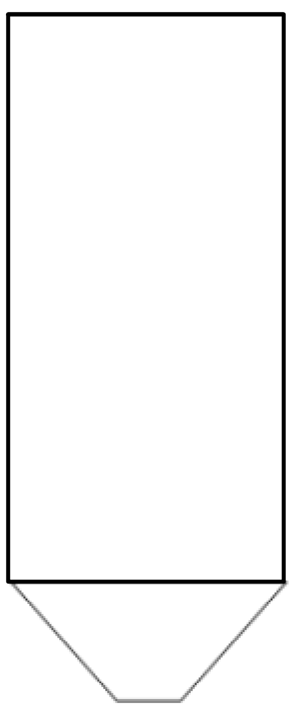
- …construct an experiment based on their design.
- …collect data to be used for later analysis.

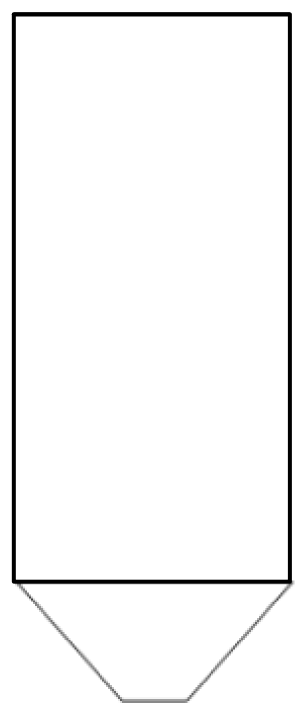
What are you thinking about as you set up your experiment? Write any questions, connections, or predictions you have as you construct your design.

Experiment Drawings









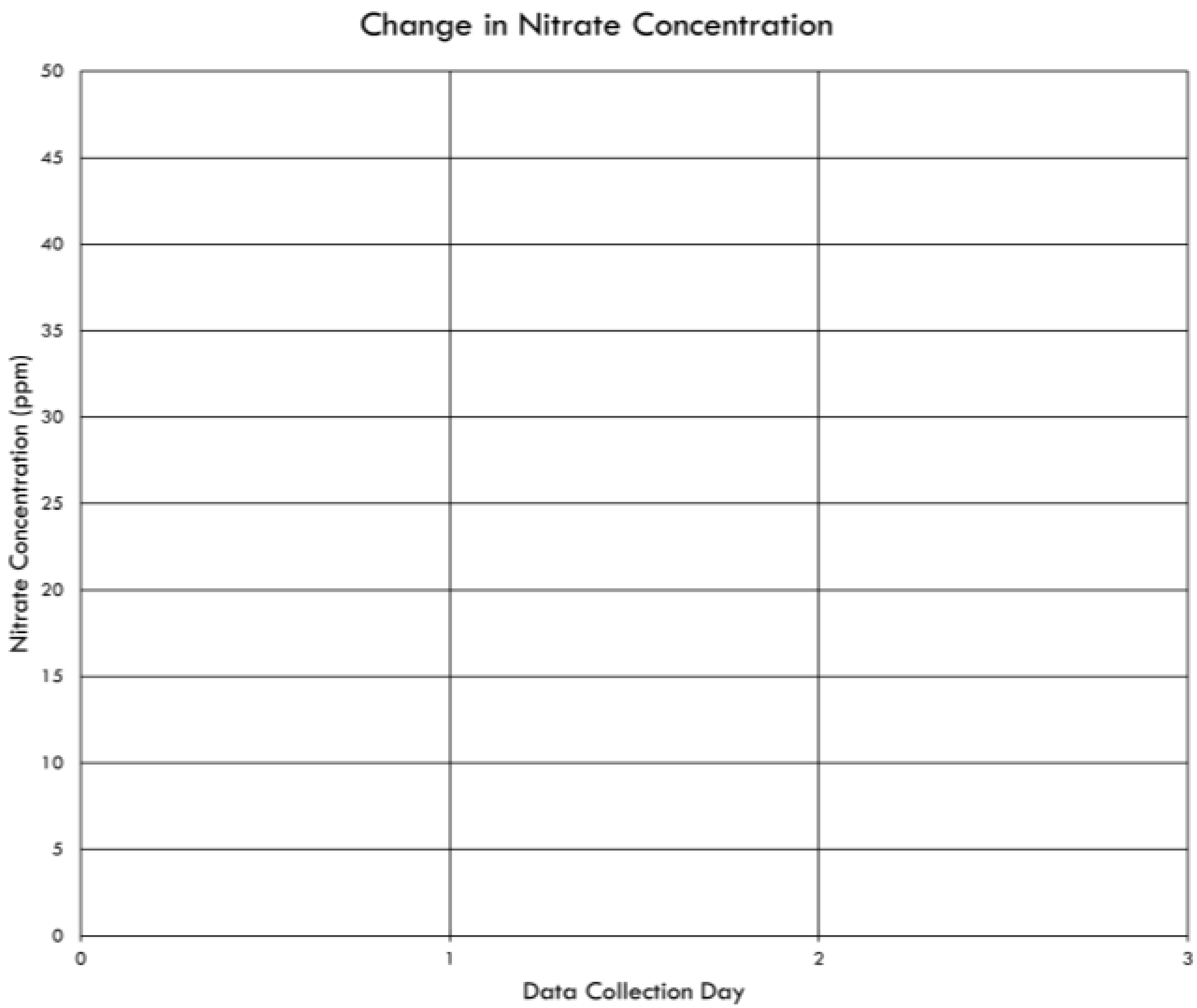
What Are the Results?

Day 6-7: Experiment

Students will…

- …collect and record data.
- …analyze data using a line plot.
- …use the data to evaluate their hypothesis and experimental design.

Data	Control	Filter	Woodchip Bioreactor	Activated Carbon
0				
1				
2				
3				



Key:

What does the trend of the data show? Does it agree with your prediction?

What Is the Solution?

Day 8: Evaluate

Students will…

- …compare the effectiveness of each method with the town's budget to decide the best solution.
- …build an argument using data to explain why they think their solution is the best.
- …implement their proposed solution in the town to maximize its impact.

Reflect on the most important discovery your team found during your experiment. What should the town consider when implementing the solution?

WATERVILLE TOWN HALL

NAME: ____________________ DATE: ______________

Data

Budget

Evidence

Solution

Experiment Reflection

Great work on helping Waterville solve the problem at Franny's Farm! Thanks to your work, the town has found a solution that will keep their waterways clean without hurting Franny's farm. Let's reflect on the experiment:

1. What was the hypothesis? Was it supported or rejected?

2. Can you think of ways the experiment might have been limited? How could it differ from the real world?

3. What are some ways we can expand on the ideas or improve the testing methods in the future?

4. Do you think of yourself as a scientist after this experiment? Why or why not?

NOTES

Glossary

Chlorine (klor-een)**:** A chemical used to keep water clean, like in swimming pools. Too much chlorine can be bad for the environment or animals.

Constant: A constant is something that is kept the same during an experiment. Constants are important because the only thing affecting the experiment should be what we meant to change, or the **independent variable**.

Dependent Variable: The dependent variable is the result that we are measuring.

Experiment: An experiment is a test to understand how things work.

Hypothesis (high-poth-uh-sis)**:** A hypothesis is a prediction for what will happen during an experiment based on background knowledge.

Independent Variable: The independent variable is the change we are making during our experiment.

Nitrate (nye-trate)**:** A chemical used in fertilizers at farms. Nitrates help plants grow.

pH: A measurement of how acidic water is. The lower the pH is, the more acidic it is. Things with a low pH are sour or spicy, like lemon juice or salsa. Water has a neutral pH of 7.

Pollution (puh-loo-shin)**:** harmful things like trash or chemicals that hurt the environment.

Water Quality: How good a water sample is for a certain purpose. For example, drinking water with high water quality is clean and tastes good. Things like **pollution**, **pH**, **nitrate**, and **chlorine** can affect water quality.

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W
E
S
SECRET SPOT
PLAYFUL PARK
LIVELY LAKE
LAB
FRANNY'S FARM
WATERVILLE