**“Solutions-Oriented Learning” Storyline**

# HS- Food Waste

## Storyline introduction and overview:

Food waste is a major contributor to greenhouse gas. Wasted food and the resources to produce that food are responsible for approximately 8% of global greenhouse gas emissions. In this storyline, students learn about the resources required to produce food through following the carbon cycle and discover how food waste contributes to climate change. They will also learn the farm to table transport chain as well as how to conduct a food waste assessment. Finally, the students will research solutions to the problem of food waste and, as a final project, present one solution that they have thoroughly researched that can be applicable to their community.

For CTE teachers, this storyline provides the basic knowledge needed to develop a deep understanding of WHY reducing food waste is an important solution to climate change. There are several potential extensions that Family Consumer Science teachers can utilize as well as Ag teachers and even Business teachers. There is a partial list at the end of the learning progressions.

**NGSS Learning Progression for this Storyline**: This high school storyline is part of a larger learning progression that includes students mastering standards pre-K to 12th grade. Take a look at how the high school performance expectations fit in a continuum of learning for your students.

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| **Placemaking:**<br>Food waste is common in homes, schools, restaurants, stores - everywhere food is produced or consumed. Washington state produces a great deal of food and some of that food ends up in landfills. Washington state has a goal to reduce food waste by 50% by 2030. | **Anchoring phenomena:**<br>When a tray of food is thrown in the trash, a whole new chain of events is set into motion. | **Drawdown:**<br>Reduced Food Waste |
| **Indigenous and other relevant cultural connections:**<br>In the Native worldview, food is a gift, not a commodity. The work of gathering and preparing food is a well planned journey throughout the course of the seasonal cycle that connects us to the communities that not only sustain us, but teach us how to live in the world. Food waste is disrespectful of the lives that sustain us and is strictly avoided. Since | **NGSS PEs (progress towards):**<br>HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions. HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts. | |

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| time immemorial, our local foods, our First Foods, have been well-managed using defined and practiced management rules. | |

## NGSS PEs:

HS-LS2-3 Construct and revise an explanation based on evidence for the cycling of matter and flow of energy in aerobic and anaerobic conditions.
HS-ETS1-3 Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics as well as possible social, cultural, and environmental impacts.

| Science & Engineering Practice (SEP) | Disciplinary Core Idea (DCI) | Cross Cutting Concept (CCC) |
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| **Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles, and theories.<br>Construct and revise an explanation based on valid and reliable evidence obtained from a variety of sources (including students' own investigations, models, theories, simulations, and peer review) and the assumption that theories and laws that describe the natural world operate today as they did in the past and will continue to do so in the future. | **LS2.B: Cycles of Matter and Energy** Transfer in Ecosystems Photosynthesis and cellular respiration (including anaerobic processes) provide most of the energy for life processes. | **Energy and Matter** Energy drives the cycling of matter within and between systems. |
| **Constructing Explanations and Designing Solutions**<br>Constructing explanations and designing solutions in 9–12 builds on K–8 experiences and progresses to explanations and designs that are supported by multiple and independent student-generated sources of evidence consistent with scientific ideas, principles and theories. Evaluate a solution to a complex real world problem, based on scientific knowledge, student-generated sources of evidence, prioritized criteria, and tradeoff considerations. | ETS1.B When evaluating solutions it is important to take into account a range of constraints including cost, safety, reliability and aesthetics and to consider social, cultural and environmental impacts. | **Connections to Engineering, Technology, and Applications of Science Influence of Science, Engineering, and Technology on Society and the Natural World**<br><br>New technologies can have deep impacts on society and the environment, including some that were not anticipated. Analysis of costs and benefits is a critical aspect of decisions about technology. |

## Learning Sessions

| Learning | Materials List: | |
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# HS- Food Waste

| Session: | | |
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| **4**<br>**6**<br>**7** | Plastic 1 liter bottles (3 bottles/student group), Food waste<br>Bromothymol Blue Indicator<br>Plastic buckets (at least 4), tarp, luggage scale for food audit | |

| **1.** | **Grounding Native Ways of Knowing** | Estimated time: 50 minutes |
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| | 1. Show the video “Reclaiming the Honorable Harvest: Robin Kimmerer at TEDxSitka”. As an introduction to the issue of food waste, students learn about indigenous ways of looking at food. The speaker, Robin Kimmerer, is a botanist, a writer, and a member of the Citizen Potawatomi Nation.<br><br>**Discussion questions:**<br><br>What do you think of the ‘one bowl, one spoon’ concept?<br>What do you think about the teachings of the ‘Honorable Harvest’:<br>● take only what you need and no more • use everything that you take<br>● minimize harm • be grateful • share what you’ve taken<br><br>Do your ideas of the ‘Honorable Harvest’ change when you add ‘Reciprocate the Gift?’ What does this mean?<br><br>How did the teaching of the ‘Honorable Harvest’ change the way you look at food? | |

| **2.** | **Examine phenomena: When a tray of food is thrown in the trash, a whole new chain of events is set into motion.** | Estimated time: 20 minutes |
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| | Image of a tray of food in the trash: Lead a discussion: What had to happen to get the food to the cafeteria? What happens to that food after it is thrown out? Record answers from the class and store away to revisit at the end of the storyline. | |

| **3.** | **Pre-Assessment:** | Estimated time: 30 minutes |
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| | Pre Assessment<br>Rubric | |

| **4.** | **Guiding question: What is Food Waste?** | Estimated time: |
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| | | Three 50 minute periods |

1. Composting in the Classroom. Students in groups will build a decomposition column out of plastic liter bottles and observe aerobic respiration during decomposition modeling composting. At the same time, use the protocol in Digest Your Food! to build anaerobic digesters to model the decomposition in a landfill. Teachers can choose to use this lesson as an experiment or to simplify so that all student groups build a digester with the same variables. To obtain good data at least a month is required, so it is a good idea to start the columns at the beginning of this unit. Building these columns could also be used as an alternative anchoring phenomena. Students set up an observation schedule that includes written observations and a photo of each model. Over the course of the month, each student group creates a time lapse video of the column including their observations (what did they see and smell). These observations will be used in a final project.
2. **Show** Food Waste video. ( 9:22 minutes) This is a good intro to food waste with some important statistics about food waste in the U.S. Prior to showing the video, display the following questions to be discussed after the video (many of the questions are addressed in the video)

- What is food waste?
- How much food is wasted?
- What resources are required to produce food?
- What greenhouse gases are produced through food waste?
- What are some solutions the video covers?

In a class discussion, answer the questions using information from the video. These questions will frame the storyline.

3. Use Exploring our Food System lesson to introduce (or review) the Food Supply Chain. If this lesson has already been introduced to your students in MS, then use only the Warm -up, the Info-graph, and the John Muir Quote activity. Then use the Washington Apple supply chain activity for a formative assessment. If your students are new to food waste, use the lesson in its entirety.

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| **5.** | **Guiding question: What Are we really wasting? What resources are required to produce food and to get the food from farm to table?** | Estimated time:<br>Two 50 minute periods |

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| | ***This is an excellent time to step out of this storyline and introduce your food chemistry unit.**<br><br>1. Ask students to consider the question, "When we waste food, what are all the things being wasted?" Give them a few minutes to jot down their ideas (labor, water, energy, transportation costs, etc.). In pairs, students organize their ideas according to what contributes most to greenhouse gases? Are there resources that can't be counted effectively?<br><br>2. Create a flow chart of all the steps in food production. Using a crop(s) that is locally relevant, have students list all the steps. Here is a guideline: growing → harvesting → transporting → storing (in a store) → consuming → disposal. At each step, students research the resources required. This work will be used at the end of the unit.<br><br>3. Using the Carbon Cycle and the role of photosynthesis/respiration (including soil respiration as well as human respiration), students draw a flow chart of carbon from the atmosphere to food consumption. This flowchart will be used at the end of the unit. Use Ecological Cycles Carbon Cycle Photosynthesis & Respiration.pptx and Dead stuff: The secret ingredient in our food chain as resources.<br><br>4. Show an image of The Methane Cycle to show how landfills produce methane. Students will draw the methane cycle on the back of the carbon flowchart. |

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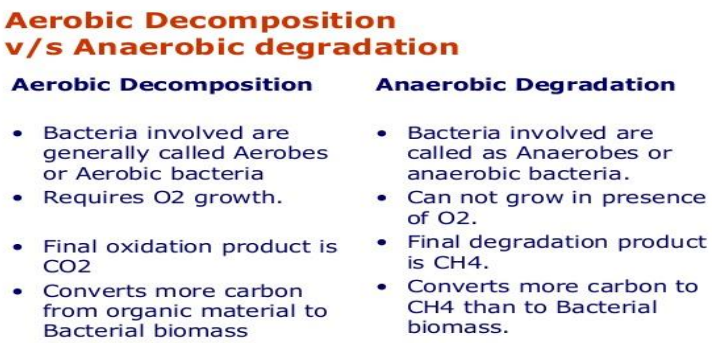
| **6.** | **Guiding question: What happens to food after the "table?" How does food waste contribute to climate change?** | Estimated time:<br>Three 50 minute periods |
| | 1. There are four phases to food decomposition in a landfill. During the first phase of decomposition, aerobic bacteria—bacteria that live only in the presence of oxygen—consume oxygen while breaking down the long molecular chains of complex carbohydrates, proteins, and lipids that comprise organic waste. The primary byproduct of this process is carbon dioxide. The second phase begins when the oxygen runs out in the landfill. Carbon dioxide and hydrogen are then available in the environment for the anaerobic bacteria that generate methane. The chemical equation for the production of methane by bacteria is:<br>$CO_2$ (g) + 4$H_2$ (g) $CH_4$ (g) + 2 $H_2O$<br>2. Use The Four Phases of Bacterial Decomposition of Landfill Waste for more in-depth information.<br>3. Introduce the terms "aerobic cellular respiration and anaerobic cellular respiration" using the graphic below. | |




4. Using the Decomposition Columns from item 4, test for CO2 in the columns using the indicator Bromothymol Blue as evidence of aerobic decomposition. Pour a dilute solution of indicator into a small test tube and place the test tube in the column overnight. During this project, you may consider the lab Carbon Dioxide Sources and Sinks
5. Students share their data from their Anaerobic Digester and ,using this evidence, make a claim as to why the decomposition column is producing CO2 and the anaerobic digester is producing methane.
6. Mythbusters tests global warming theory - does CO2 (and methane) warm air? Students watch the video and answer the question using evidence from the video (teachers could ask students to identify the variable and the control). The evidence from the video will help students make predictions/conclusions about the differences between their decomposition columns.

7. Students research WHY methane is considered a GHG and how it compares to other GHG. Use the readings The Methane Cycle and Greenhouse Gases, CO2, CO2e, and Carbon:What Do All These Terms Mean?.

8. Students conduct a web search to discover what services are available locally for recycling the food waste in their community. Consider visiting a composting facility or having a guest speaker from a composting facility come to the school. Master gardeners are an additional source of information.

Possible extension: Watch the video The Smelly, Oozy, Sometimes Explode -y Science of Garbage

| 7. | **Guiding question: What are some solutions to food waste?** | Estimated time: Four 50 minute periods |
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1. Students conduct a food assessment either at school, at their local grocery store, at their favorite restaurant, or at their home using one of the following resources:
   Use School Food Waste Assessment for the protocol of a school based food audit.
   Use A Guide to Conducting and Analyzing a Food Waste Assessment - EPA for audits in other facilities. This assessment describes a visual audit if a physical audit is not possible (see page 13 for the visual assessment). Upon completion of the assessment, students will have a better understanding of the extent of food waste in their lives.

2. Use the Food Citizen's Action Project for a step by step protocol. The teacher page showing examples is a good template to use for the students.

3. Reference Washington state's legislative goal to halve food waste in this state by 2030. Read and discuss House Bill 1411 as an introduction to the final project.

4. Have students watch Intermarché Inglorious Fruits and Vegetables or Edible but Ugly. Invite a buyer from a local grocery store, a representative from the school district food services and a local farmer in to talk with the class about Edible, but Ugly | The New York Times what happens to inglorious fruits and vegetables in your community. Determine if there are steps that can be taken to reduce food waste and support local farmers.

5. Project Drawdown has listed "Reduce Food Waste" as the #3 global solution to lowering the $CO_2$ in our atmosphere. After reading, students list the solutions from the reading. As a homework assignment, students research another solution to food waste that is happening either in or outside of the U.S. Spend one class session having students share the solution they researched.

| 8. | **Guiding question: What can I do to reduce food waste in my community?** | Estimated time: Three 50 minute periods |
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1. Show and discuss EPA's Food Recovery Hierarchy**.** Divide your class into 5 groups and assign each group one of the 5 levels of food recovery. Each group will prepare a presentation that describes at least 2 solutions along with the criteria for implementing that solution as well as a constraint on that solution. (A **constraint** is a limitation or condition that must be satisfied by a design. A **criterion** is a standard or attribute of a design that can be measured). Use the worksheet Worksheet for Food Recovery Hierarchy to guide the activity.

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| | 2. As a final project, students create and display informational posters "What is Being Wasted When Food is Thrown Away?".<br>The posters will show<br>● the food supply chain starting with a food crop being planted and ending with food waste in a landfill.<br>● how the teachings of the Honorable Harvest minimize food waste<br>● where carbon is stored and where carbon dioxide and methane are being released into the atmosphere as food is grown and moved from farm to table to food waste.<br>● highlight ONE solution that the students choose as a means of reducing food waste in their community and ultimately a solution to climate change. The student will show where in the cycle his/her solution could be implemented.<br>These posters could be presented to local business organizations or local government agencies.<br><br>3. Revisit the Decomposition Columns. Each student group creates a time lapse video of the column including their observations (what did they smell). Each group will write a summary describing the aerobic and anaerobic activity in the models and how each process contributes to GHG in the atmosphere. This can be used as a performance evaluation. |

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| **9.** | **Possible next steps/off-ramps/actions** | |
| | **CTE Extensions:** | |
| | ● For Family/Consumer Science teachers: Use the storyline as written through to the final project. At this point, your students could research other aspects of food waste such as:<br>a. The grading of fresh food - what are the criteria? Aesthetics vs. quality. Use The Dating Game: How Confusing Food Date Labels Lead to Food Waste in America curriculum<br>b. The laws that govern giving food away<br>c. The social habits of consumers - why do U.S. consumers tend to overbuy food? Use The Progressive Increase of Food Waste in America and Its Environmental Impact journal article. This study gives good practice at reading graphs and looking at how a scientific study is done.<br>d. Research the question "Why is processed or 'fast' food less expensive than fresh food?"<br>e. The start up companies that are trying to connect businesses with excess food to agencies that serve food to needy people<br>● For Agriculture teachers: Use the storyline as written through to the final project. At this point, your students could research other aspects of food waste such as:<br>f. Harvesting and storage methods | |

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| | g. The grading of fresh food- what are the criteria?<br>• Students participate in Biomimicry Global Design Challenge. This is a competition in which students design solutions to climate change related problems.<br>• Contact your local WA State Dept of Ecology to inquire as to who is doing composting commercially in the area and organize a field trip.<br>• Use the principles of Lean (What is lean?) to investigate how industry can discover sources of waste. This is a great activity to model in your school by walking through the "food path" from cafeteria to dumpster. Analyze evidence of waste through direct observation of food on the floor, food in a garbage can, etc. Also analyze the waste of additional resources (other than food) such as time of the people who must handle the food waste. Intro to Lean video "Toast Kaizen"<br>• Food Citizen Action Project<br>• If students are interested in what kind of jobs there might be in working to reduce food waste, they can research careers in food sustainability. These careers range from farming and research to media, communication and advocacy positions to policy and public health jobs. For more detail, see Get to Work! Jobs in Food Sustainability. |

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| **10** | **Post Assessment:** | Estimated time: 30 minutes |
| | HS-Food Waste Post Assessment<br>HS-Food Waste Assessment Rubric | |

## Food Waste OER Tracker

Pacific Education Institute would like to acknowledge and thank the writing team for their work. The team included Michelle Townshend, Laura Tucker, Cinnamon Bear and Shelley Stromholt. In you have comments or questions please contact info@pacificeducationinstitute.org .