TRACKING TRASH!

Dauphin Island Sea Lab
Discovery Hall Programs
Education and Outreach

GULF STAR
GULF OF MEXICO ALLIANCE

Lesson 3: The Mobile Bay watershed: Where does the debris come from and go?

Overview

What is a watershed? How critical to Alabama is the Mobile Bay watershed? What are some of the factors that impact water quality in the Mobile Bay watershed? In this lesson, students deepen their understanding of a watershed and land forms by building and then impacting a watershed. They then trace the connectedness of their local watershed to the Mobile Bay watershed using an interactive website and explore a 3d model of Mobile Bay to better understand how estuaries are impacted by upstream activities.

Materials / Resources

- 3d model of Mobile Bay with bucket, water supply (currently, this can only be borrowed from DISL) but it can be printed in a smaller version on a 3d printer
- Cafeteria trays, paint roller pan liners or other large, flat pans with a small lip (to contain water)
- Materials to build a watershed model
    - Newspaper, aluminum foil to construct land forms, permanent markers
    - Spray bottles for rain (and runoff) making
    - Materials to represent dissolved and particulate matter that occur in land runoff
        - Colored powders/sediments that will dissolve (ex. Koolaid, cocoa in vegetable oil)
        - Sediments that will not dissolve in water (red clay, silt)
        - Small pieces of organic materials (ex. pieces of leaves) and plastic as debris
    - Note that as a substitute for students building their own watershed, an EnviroScape model can be used to model parts of the watershed, how impacts are magnified when waterways merge and practices that can be used to help mitigate these impacts (but it's not as interactive or fun).
    - Watersheds can also be constructed as an outside activity using larger items (buckets, logs, balls, etc.) to construct hills, plastic tablecovers to provide a land surface and access to a garden hose to provide water.
- Map of Alabama with waterways noted (suggested: Rivers and Streams of Alabama, Alabama Geological Survey)
- Map handouts with Alabama's major watersheds outlined (included)
    - Also provided as a puzzle for younger audiences
- Computer access to https://txpub.usgs.gov/DSS/streamer/web/
    - Read more about the Streamer app at https://www.usgs.gov/news/follow-your-stream-to-learn-about-water. A mobile friendly version is under development, so check back to see its status.

Student objectives

- Explain major aspects of the geography and bathymetry of Mobile Bay
- Discuss flow patterns in Mobile Bay recognizing that water does not move through the bay uniformly
- Construct a model of a watershed, noting areas where materials accumulate and interact
- Explain real life analogs of materials added to the watershed (debris, dissolved, particulate materials) and distinguish between point and non-point source pollution
- Explain how materials in individual Alabama watersheds are transported to Mobile Bay
- Effectively use the Streamer interactive watershed mapper to trace upstream and downstream watersheds of specific locations

Time required

- approximately 20 min to explain bathymetry of Mobile Bay, demonstrate flow through the bay, discussing areas of direct flow and areas of slower flow and accumulation

- approximately 15 min for introduction to watersheds, land forms
- approximately 10 min for construction of watersheds
- approximately 10 min for adding materials and discussing impacts to the watershed

Note - This is a good stopping point in the lesson plan.

- approximately 20 min for introduction to Alabama's watersheds, review map (if chose to have students color watershed map, more time required)
- approximately 20 min to explore Streamer mapping watersheds upstream and downstream of given locations

Engage

The teacher will:

- Introduce the Mobile Bay model, explaining its geography and bathymetry (river inflows, delta, Bayway & Causeway crossings, average depth, ship channel, Gaillard Island, Mississippi Sound, Dauphin Island, Fort Morgan peninsulas, connection to Gulf)
- Demonstrate the flow of water through the Mobile Bay model showing that water does not flow uniformly though the bay (dyes can be useful in following the flow)
- Present a map of the Mobile Bay watershed, defining it as an estuary and emphasizing the extent of its drainage area and narrow connections to the Gulf of Mexico
- Ask students to define a watershed and have students discuss possible inputs to the bay from surrounding land and upstream flow

Explore / Activity

Building the watershed model…

- Have students brainstorm and share different types of landforms, constructing a list on the board
- Divide students into groups with 4-6 students per group
- Provide trays, paper and aluminum foil to student groups and ask them to construct a model that includes at least 2 landforms (hills, mountains, valleys, plains, plateaus, rivers, streams, lakes, ponds and estuaries) and 2 land uses (agricultural, industrial, city, suburban) allowing them about 10 min or so
- Ask student groups to define the watershed(s) on their model and predict how water will flow within the watershed using sharpie markers
- Have them test the watershed by allowing each group to use a spray bottle to gently "rain" on their watershed
- Have students **sparingly** sprinkle or drip some of the colored powders, cocoa, clay and debris onto appropriate areas of their watershed (for ex. green = fertilizer/nutrients; red = chemical pollution; cocoa oil = oil; clay = sediment runoff; plastics = non-biodegradable debris ☺; leaves = organic debris)
- Have groups make it rain again (gently) and observe the runoff

Explain

Have each student group discuss what has happened in their watershed. Did the 'rain' accumulate where they predicted it would? Did the sources of runoff dissolve in the 'rain' or did they stay as particles? Did the materials stay separate or did they mix? Was there a pattern to what was observed? What materials represent non-point source pollution? Point source pollution? Would it be possible to easily remove sources of pollution? Why or why not? How?

Bring groups back together, having student groups share their explanations, correcting misunderstandings as needed.

Returning to the Mobile Bay watershed, lead students to consider what flows into the estuary from upstream sources, making comparisons to student models. Have students consider the magnitude of the inputs to Mobile Bay which receives water and dissolved / particulate materials from the majority of the state (4th largest in nation by discharge, the volume of water flowing through the bay).

Lead the students in a discussion about how to clean up (removing pollution - dissolved and particulate materials) the bay. Is this easy? Can it be done for single pollutants? Are there ways that the input of these pollutants could be stopped before getting to the bay?

Extend (Environmental Science, Social studies)

Marine debris
Have students focus specifically on the plastic debris they added to their watershed model. Have them discuss (or research) whether plastics will biodegrade. What is the fate of these plastics? Are there ways to remove the plastic before it reaches the bay? Where will it ultimately end up?

Community connections
The Watershed Game (classroom version), developed by the University of Minnesota Sea Grant program (available through https://watershedgame.umn.edu; copies held by Dauphin Island Sea Lab as well as the University of Alabama National Water Center) leads students through managing a watershed. Students gain an understanding of impacts to watersheds from various land uses but also learn through play that management for clean, healthy water requires collaboration among interest groups.

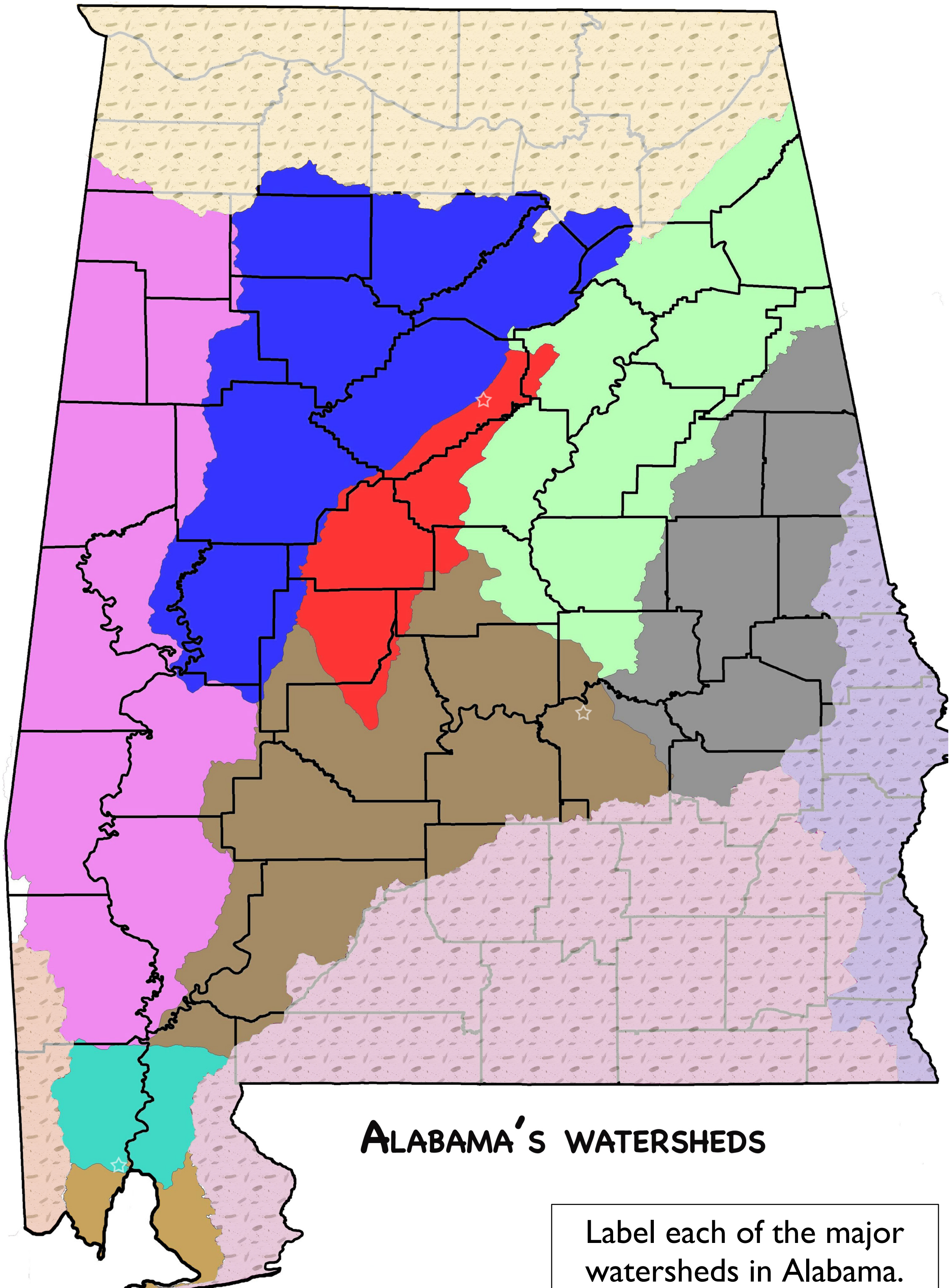
Evaluate and assess

Possible evaluation tools address:

- Knowledge of Mobile Bay's major features
- Ability to use Streamer app
- Degree to which model includes different landforms and land uses
- Ability to explain water flow / runoff to a single area in model (watershed concept)
- Understanding of pollution analogs (green powder represents? Clay represents?, etc.)
- Explanations of dissolved vs particulate pollutants
- Recognition that it is very difficult to separate dissolved materials from each other once they have combined
- Recognition that it is possible to reduce pollution inputs with proper land use; creativity in describing solutions

Related Activities

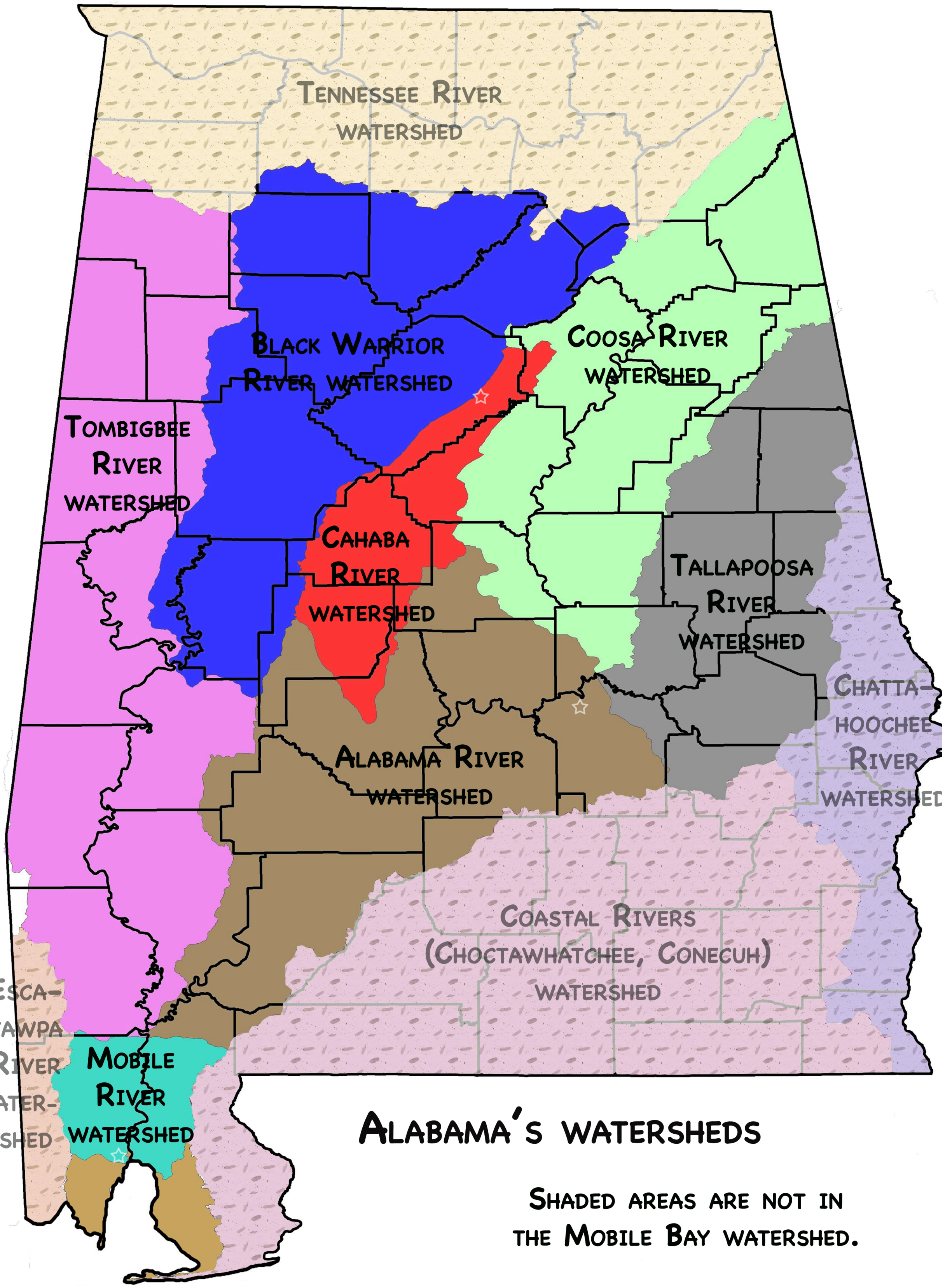
Note that this lesson plan is Lesson 3 of a 5 part curriculum titled *Tracking Trash*. The curriculum focuses on the problem of aquatic debris. Lessons address what is and is not debris (Lesson 1), the problem of microplastics (Lesson 2), how scientists use current drifters to track currents (Lesson 4) and how we might use current information and drifters to help solve the aquatic debris problem (Lesson 5). Lessons include a variety of activities, some are web-based, some are hands-on, some are well suited for individual work, while others involve group work. In Lesson 4, students design and build a current drifter prototype making it also suitable for STEM classes. Each lesson plan also includes a number of extension activities allowing instructors to tailor lessons to their audience and geographic area.



Alabama's watersheds

Label each of the major watersheds in Alabama.

Key



Alabama's watersheds

Shaded areas are not in the Mobile Bay watershed.

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Lesson 3: The Mobile Bay Watershed

<u>Alabama Course of Study (ALCOS)</u>

Science:

5th Grade, Science, Earth's Systems, Content Standard 14

Use a model to represent how any two systems, specifically the atmosphere, biosphere, geosphere, and/or hydrosphere, interact and support life.

5th Grade, Science, Earth and Human Activity, Content Standard 16

Collect and organize scientific ideas that individuals and communities can use to protect Earth's natural resources and its environment.

5th Grade, Science, Earth and Human Activity, Content Standard 17

Design solutions, test, and revise a process for cleaning a polluted environment.

6th Grade, Science, Earth and Human Activity, Content Standard 16

Implement scientific principles to design processes for monitoring and minimizing human impact on the environment.

7th Grade, Science, Ecosystems: Interactions, Energy, & Dynamics, Content Standard 7

Use empirical evidence from patterns and data to demonstrate how changes to physical or biological components of an ecosystem can lead to shifts in populations.

7th Grade, Science, Ecosystems: Interactions, Energy, and Dynamics, Content Standard 9

Engage in argument to defend the effectiveness of a design solution that maintains biodiversity and ecosystem services.

9-12th Grade, Biology, Content Standard 8

Develop and use models to describe the cycling of matter and flow of energy between abiotic and biotic factors in ecosystems.

9-12th Grade, Environmental Science, Content Standard 10

Design solutions for protection of natural water resources considering properties, uses, and pollutants.

9-12th Grade, Agriculture, Food, and Natural Resources, Content Standard 4

Describe methods of managing waste.

9-12th Grade, Agriculture, Food, and Natural Resources, Content Standard 9

Identify major contaminants in water resulting from natural phenomena, housing, industrial waste, and agricultural pollutants.

9-12th Grade, Agriculture, Food, and Natural Resources, Content Standard 16

Identify the influence of human populations, technology, and cultural and industrial changes on the environment.

Digital Literacy and Computer Science:

6th Grade DLIT, Content Standard 30

Discuss and apply the components of the problem-solving process.

8th Grade, DLIT, Content Standard 25

Create a model that represents a system.

Math:

n/a

Social Studies:

5th Grade, Social Studies, Content Standard 1

Locate on a map physical features that impacted the exploration and settlement of the Americas including ocean currents, prevailing winds, large forests, major rivers and significant mountain ranges.

7th Grade, Geography, Content Standard 1

Describe the world in spatial terms using maps and other geographic representations, tools, and technologies.

7th Grade, Geography, Content Standard 3

Compare geographic patterns in the environment that result from processes within the atmosphere, biosphere, lithosphere, and hydrosphere of Earth's physical systems.

7th Grade Geography, Content Standard 9

Explain how human activities modify the physical environment within and between places, including how human-induced changes affect the environment.

Ocean Literacy Standards

Essential Principle 1: The Earth has one big ocean with many features.

g. The ocean is connected to major lakes, watersheds and waterways because all major watersheds on Earth drain to the ocean. Rivers and streams transport nutrients, salts, sediments, and pollutants from watersheds to estuaries and to the ocean.

Essential Principle 6: The ocean and humans are inextricably interconnected.

d. Humans affect the ocean in a variety of ways. Laws, regulations and resource management affect what is taken out and put into the ocean. Human development and activity leads to pollution (point source, non-point source, and noise pollution), changes to ocean chemistry (ocean acidification) and physical modifications (changes to beaches, shores and rivers). In addition, humans have removed most of the large vertebrates from the ocean.

g. Everyone is responsible for caring for the ocean. The ocean sustains life on Earth and humans must live in ways that sustain the ocean. Individual and collective actions are needed to effectively manage ocean resources for all.

Next Generation Science Standards (NGSS)

5-ESS2-1: Earth's Systems: Develop a model using an example to describe ways the geosphere, biosphere, hydrosphere, and/or atmosphere interact

5-ESS3-1: Earth and Human Activity: Obtain and combine information about ways individual communities use science ideas to protect the Earth's resources and environment

3-5-ETS1-1: Engineering Design: Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.

3-5-ETS1-2: Engineering Design: Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem

MS-ESS3-3: Earth and Human Activity: Apply scientific principles to design a method for monitoring and minimizing human impact on the environment.

MS-ETS1-1: **Engineering Design**: Define the Criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-2: Engineering Design: Evaluate competing design solutions using a systematic process to determine how well they will meet the criteria and constraints of the problem.

HS-LS2-7: Ecosystems: Interactions, Energy, and Dynamics: Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.

HS-ESS3-4: Earth and Human Activity: Evaluate or refine a technological solution that reduces impacts of human activities on natural systems.

HS-ETS1-1: Engineering Design: Analyze a major global challenge to specify qualitative and quantitative criteria and constraints that account for societal needs and wants.

HS-ETS1-2: **Engineering Design**: Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

SEPs:	**DCIs**	**CCCs**
-Developing and using models -Obtaining, evaluating and communicating information -Asking questions and defining	-ESS2.A: Earth Materials and Systems -ESS3.C: Human Impacts on Earth Systems	-Systems and system models -Influence of Science, Engineering, and Technology on society and the natural world

problems -Constructing explanations and designing solutions -Engaging in Argument from Evidence	-ETS1.A: Defining and Delimiting Engineering Problems -ETS1.B: Developing possible solutions -ETS1.C: Optimizing the design solution -LS2.C: Ecosystem Dynamics, Functioning, and Resilience -LS4.D: Biodiversity and Humans	-Stability and Change

Additional standards covered in Extension Activities:

5th Grade, Math, Content Standard 8
Fluently multiply multi-digit whole numbers using the standard algorithm.
(Watershed modeling)

5th Grade, Math, Content Standard 15
Interpret multiplication as scaling (resizing).
(Watershed modeling)

5th Grade, DLIT, Content Standard R5
Locate and curate information from digital sources to answer research questions.
(Marine Debris)

6th Grade, DLIT, Content Standard R5
Locate and curate information from digital sources to answer research questions.
(Marine Debris)

6th Grade, DLIT, Content Standard 27
Explain how simulations serve to implement models.
(Community Connections)

7th Grade, Math, Content Standard 6
Solve real-world and mathematical problems involving the four operations with rational numbers.
(Watershed modeling)

7th Grade, DLIT, Content Standard R5
Locate and curate information from digital sources to answer research questions.
(Marine Debris)

8th Grade, DLIT, Content Standard R5
Locate and curate information from digital sources to answer research questions.
(Marine Debris)

9-12th Grade, Math, Algebra 1, Content Standard 4
Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose, interpret the scale and the origin in graphs and data displays.
(Watershed modeling)

9-12th Grade, Math, Algebra 1, Content Standard 5
Define appropriate quantities for the purpose of descriptive modeling.
(Watershed modeling)

9-12th Grade, Math, Algebraic Connections1, Content Standard 11
Use ratios of perimeters, areas, and volumes of similar figures to solve applied problems.
(Watershed modeling)

9-12th Grade, DLIT, Content Standard R5
Locate and curate information from digital sources to answer research questions.
(Marine Debris)

NGSS: HS-LS4-6: Biological Evolution: Unity and Diversity
Create or revise a simulation to test a solution to mitigate adverse impacts of human activity on biodiversity.
(Community Connections)

HS-ETS1-4: Engineering Design:
Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.
(Community Connections)