the CEED

THE CENTER FOR ENERGY EFFICIENT DESIGN

Green Roof

Grade Level	4th	Subject	Science

Objective(s):

Investigate and understand how green roofs can help manage stormwater runoff and protect watersheds.

Design a model of a green roof.

Use appropriate instruments to measure the volume of a liquid.

SOL Addressed:

4.1 (c, e, k, l, m) The student will demonstrate an understanding of scientific reasoning, logic, and the nature of science by planning and conducting investigations in which:

- **c) appropriate instruments are used to measure volume**
- **e) predictions and inferences are made, and conclusions are drawn based on data from a variety of sources**
- **k) data are communicated with simple graphs, pictures, written statements, and numbers**
- **l) models are constructed to clarify explanations, demonstrate relationships, and solve needs**
- **m) current applications are used to reinforce science concepts**

4.4 (c, d) The student will investigate and understand basic plant anatomy and life processes. Key concepts include:

- **c) photosynthesis**

4.5 (f) The student will investigate and understand how plants and animals, including humans, in an ecosystem interact with one another and with the nonliving components in the ecosystem. Key concepts include:

- **f) influences of human activity on ecosystems**

4.9 (a) The student will investigate and understand important Virginia natural resources. Key concepts include:

- **watersheds and water resources**

Common Core Standards:

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

- **Human impact on Earth's Systems – Individuals and communities are doing things to help protect Earth's resources and environments.**

Materials Needed Per Class of 30 **and** **Prior Knowledge**	**Materials:** • **CEED dashboard link http://dashboard.intellergy.us/ceed/** • **National Geographic Picture Slide Show** • **Green Roof PowerPoint (See attachment)** • **Student Directions Handout (See attachment)** • **1 Small plastic square box per group (3-4 students in a group)** • **Soil** • **1 coffee filter per group** • **Bag of small stones** • **Bag of soil** • **Sand** • **Bag of peat moss** • **Bag of organic compost** • **1 small plant per group** • **Scissors** • **Large tray** • **Measuring cup** • **Digital scale** • **Water** **Prior Knowledge:** • **Know how to use a graduated cylinder to measure volume of a liquid.** • **Know how to use a digital scale to measure mass.** • **Understanding of photosynthesis** • **Knowledge of watersheds & groundwater**
Ways to differentiate this lesson plan	**EXTENSION** My School's Green Roof 1. For an extension activity, students could be directed to find the total area of the school's roof by measuring around the buildings. They would need to find the total area that would be covered by a green roof. 2. According to the mass of the green roof model that students created in this lesson, students will calculate the total mass it would be to plant a green roof on the total area of the school's roof. 3. Do you think the school roof would be sturdy enough to hold the mass of the green roof? 4. If you were to plant a green roof, think about what the mass might be once it rains, or the green roof is watered. 5. Write an explanation of possible positive and negative effects of planting a green roof on your school. **MODIFICATIONS** • If needed, the teacher can tell students exactly how much soil, peat moss, compost, and sand to create the engineered soil instead of letting students mix their own. • The teacher can provide a model of a green roof already prepared so that students can see an example of what they are going to create. • The teacher can provide a formula for students to calculate how much water the green roof is holding.

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Instructional Activities

<table>
<tr><td>Introduction/
Anticipatory Set</td><td>Anticipatory Set:
The teacher will ask students the questions listed below to get them thinking about the purpose of roofs. Then the teacher will show a National Geographic picture slide show about green roofs to get students interested in this concept.

Questions to ask students:
What does a roof do?
What are roofs made of?
Can you think of any other materials that could be used to make a roof?</td><td>Introduction:
What does taking care of the environment mean to you? Is it important to take care of our environment? What are some ways we can take care of our watershed? One way we can take care of our watershed is actually right over our heads!</td></tr>
<tr><td>Guided Practice</td><td colspan="2"><u>Day 1</u>
Anticipatory Set – Discussion questions and National Geographic Slide Show.
Open the Green Roof PowerPoint and guide students through a lesson about the benefits of green roofs.
Review the PowerPoint by asking students to tell you the main reasons and benefits to planting a green roof. Explain that we will be investigating and discovering how green roofs can help manage stormwater.
Have you ever thought about where water goes after a heavy rain or snow storm? -To keep streets from flooding, rainwater goes into storm drains, into the ground, and eventually to natural bodies of water where it will be absorbed. Most likely, much of the rain will end up in your local stream and in your watershed.
What is a watershed? -A watershed is the land that catches water from rain then drains it into groundwater, streams, rivers, lakes and eventually to a single, large collection area such as a bay or ocean.
Stormwater is rainfall and snowmelt that seeps into the ground, or runs off the land into storm drains, streams, lakes, etc. Stormwater can also include water runoff from washing cars and watering lawns.
How do you think roofs are connected to the watershed? - Runoff from a roof ends up in our watershed. During heavy rain storms, many storm drains cannot handle all of the water that is draining into them. The water could flood and cause other problems like soil erosion. Green roofs are much better at handling the rainwater than a typical roof because they are like a giant sponge that can soak up the rain. On a green roof, the water slowly soaks into the soil and plants; therefore it does not flood the drains as easily. Managing stormwater is just one of the many benefits of a green roof.
We have an extremely valuable resource in our county, the Center for Energy Efficient Design building (CEED). Connect to the CEED Dashboard page and show students the design of the building and how it has a model of a green roof. Also point out that the CEED building has a rainwater storage tank underground that collects rainwater from the roof, gutters, and through a permeable walkway. The water in the tank is then used to do things such as flush toilets. Click on the “Rainwater Storage” picture and it will link you to valuable real-time information about the rainwater storage tanks and water usage.</td></tr>
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Instructional Activities

Independent Practice	1. Explain to students that one important part of a green roof is the special soil used, called engineered soil. Engineered soil is lighter and can absorb more water than average soil. It is made of a mixture of sand, gravel, peat moss, crushed brick, organic matter, and soil. 2. Today, you will work in groups of 3-4 to create a model of a green roof. Each group will make your own version of engineered soil. Try to be the group to create the lightest and most absorbent soil. 3. Give one copy of the attached directions and activity sheet to each group (linked in materials). Students will work within cooperative groups to complete the activity. 4. Students will present their results to the class.
Closure (Summary of Lesson)	• Ask each group to tell the class how they created their own special soil. What materials did they use? How much of each material did they use? • Ask each group to compare information and make a decision on which group created the most beneficial soil for a green roof. They must be able to explain why they think it was the best. • Ask students how they could improve and/or modify the green roof models they created.
CEED Building Application/ Sensor Data	• The students will access the CEED dashboard and observe the model of a green roof. • The students will access the CEED dashboard and investigate information gained in real-time about the rainwater storage tanks at the CEED building.
Assessment	• Students will be informally assessed by teacher observation, student participation, and student discussion. • Students will reflect on what they learned by writing an exit slip. • Unit test questions

Green Roof Model Activity

Group Members: _____ Date: _____

Materials Needed:

- 1 small plastic square container
- 1 coffee filter
- Small stones
- Soil
- Sand
- Peat moss
- Organic compost
- 1 small plant
- Scissors
- Large tray
- Measuring cup
- Digital scale
- Water

Directions:

1. Poke 6 holes in the bottom of the plastic square container. Ask your teacher to help you if needed. Be careful!
2. Add 1-2 cups of small stones in the bottom of the container.
3. Trim the coffee filter to make it the same size and shape as the container.
4. Put the coffee filter on top of the stones.
5. Create your own special soil (engineered soil). Use different amounts of soil, peat moss, organic compost, and sand. Measure the weight (grams) of each material that you use and record below.

   Soil _____
   Peat Moss _____
   Compost _____
   Sand _____

6. Add your special soil until it is 5 cm from the top of the square container.
7. Plant your small plants into the soil.
8. Weigh the container using a digital scale.

   Weight of container: _____ grams

9. Place the container over a large tray and water the plant with increments of 20 mL of water until it drips. When it first starts to drip, do NOT pour more water into the container.
10. Once the water has stopped dripping, weigh the container again.
    Weight of container: _____ grams
11. Calculate how much water your "green roof" is still holding. Show your math calculations below.

My green roof is holding _____ grams of water.

12. Challenge: Calculate the volume of the water that your green roof is still holding. Put the measuring cup on the scale. Fill the measuring cup with water until you have the same weight as your answer to how much water your green roof is still holding.
    The model green roof is holding _____ mL of water.

INQUIRY LEARNING RESEARCH PROCESS GUIDELINES

The following table is just one guideline to use for developing your own inquiry materials. The seven steps in the Learning Research Process include not only how people learn but also how research is conducted. The heart of the design, the three-stage learning cycle of exploration, concept invention or formation, and application is embedded in the middle. In addition to these three stages, this design takes into account that learners need to be motivated to spend the time required for understanding complex subjects and that learners need to build this new knowledge onto prior knowledge. These are similar to the 5E and 7E learning models.

The Learning-Research Process

Steps in the Learning-Research Process	7E Equivalent	Component of the Activity
1. Identify a need to learn.	Engage	An issue that excites and interests is presented. An answer to the question *Why?* is given. Learning objectives and success criteria are defined.
2. Connect to prior understandings.	Elicit	A question or issue is raised, and student explanations or predictions are sought. Prerequisite material and understanding is identified.
3. Explore	Explore	A model or task is provided, and resource material is identified. Students explore the model or task in response to critical-thinking questions.
4. Concept invention, introduction, and formation	Explain	Critical-thinking questions lead to the identification of concepts, and understanding is developed.
5. Practice applying knowledge.		Skill exercises involved straightforward application of the knowledge.
6. Apply knowledge in new contexts.	Elaborate and Extend	Problems and extended problems require synthesis and transference of concepts.
7. Reflect on the process	Evaluate	Problem solutions and answers to questions are validated and integrated with concepts. Learning and performance are assess

Hanson, D. (2006). POGIL Instructor's Guide to Process-Oriented Guided-Inquiry Learning. Lisle, IL: Pacific Crest