American Association of Petroleum Geologists Foundation

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Designing Rain Gardens for Stormwater Solutions

Curriculum Outline

Background: This curriculum guides students in understanding stormwater issues on their school grounds and designing a rain garden as a possible solution. Tailored for middle or high school students, it incorporates hands-on activities, real-world data analysis, and collaborative problem-solving. Each lesson within the curriculum can be customized to suit varying grade levels, student needs, and local environmental conditions. Educators and outreach specialists are encouraged to modify the content to align with their goals, resources, and time, ensuring relevance and impact. The complete set of lessons, which includes background information, more complete instructional guidance, and suggested responses can be found here.

Grade Level: 6–12

Duration: Six 50-minute lessons

STANDARDS

NGSS: MS-ESS2-4, MS-ESS3-3, MS-ETS1-1, MS-ETS-2, HS-ESS2-5, HS-ESS3-4, HS-ETS1-1, HS-ETS1-2
SDG 6: Clean water and sanitation
SDG 11: Sustainable cities and communities

Learn more about the United Nation's Sustainable Development Goals (SDGs) and explore resources for educators from UNESCO.

A rain garden shortly after a rain event.
Credit: R. Ford, EPA-ORD

LESSONS WITHIN THIS CURRICULUM

Day	Lesson Title
1	Introduction to Stormwater Runoff
2	Site Analysis in the Field for Land Cover and Topography
3	Digital Analysis of Land Cover and Topography
4	Weather Data and Calculating Rain Garden Size
5	Soil Analysis for Rain Garden Design
6	Designing the Rain Garden

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DAY 1: INTRODUCTION TO STORMWATER RUNOFF

Objective: Students will understand what stormwater runoff is, why it is an issue, and how it impacts the environment.

Activities

1. **Watershed Demonstration:** Use a model (such as an **EnviroScape**) to simulate stormwater runoff, showing how water naturally flows through pervious areas and can become polluted when passing over impervious surfaces. Simulate pollutants (e.g., cocoa powder, food coloring) being washed into bodies of water during rainfall.

2. **Identify and Learn About Your Watershed:**
   a. Use online tools, like USGS's **Locate your Watershed**, for students to identify their school's watershed. Scroll over the blue lines to get the names of the waterways.

   b. Dive deeper into the health of identified streams and rivers using USGS's **How's my Waterway** tool. Examine water quality data and pollutant levels and then consider how pollutants from the schoolyard, and erosion from the increased water flow entering these systems, might affect downstream ecosystems.

   c. Use the **River Runner** tool to select their school's location and simulate where a single raindrop would end up. Consider the impact of the pollution previously discussed and connect the local environment to a larger watershed system.

3. **Class Discussion:**
   - What causes stormwater runoff?
   - How do human activities exacerbate the problem?
   - Why should we care about managing stormwater?

DAY 2: SITE ANALYSIS IN THE FIELD FOR LAND COVER AND TOPOGRAPHY

Objective: Students will explore the schoolyard to differentiate between pervious and impervious surfaces, analyze topography, and predict water flow patterns.

Activities

1. **Outdoor Exploration:**
   a. Students map the schoolyard, identifying pervious (grass, soil) and impervious (pavement, rooftops) surfaces.

   b. Use tools such as tape measures or digital tools like smartphone level apps to identify slopes and elevation changes in key areas.

2. **Water Flow Prediction:**
   a. Have students hypothesize how water would flow over parts of the schoolyard with different conditions (e.g., heavy rain).

   b. Tell students to mark potential low points and pooling areas on their maps. Ask them to explain what leads them to mark those areas.

   c. Discuss natural and man-made drainage features (e.g., storm drains, gutters).

3. **Group Discussion:**
   - Why does runoff not occur as much on pervious surfaces as it does on impervious surfaces?
   - How does topography influence water flow?
   - What areas in the schoolyard might be good candidates for a rain garden based on surface type and slope?

DAY 3: DIGITAL ANALYSIS OF LAND COVER AND TOPOGRAPHY

Objective: Students will use digital tools and topographic maps to explore land cover and identify potential sites for a rain garden.

Activities

1. **Digital Mapping with EnviroAtlas:** Students explore land cover maps to identify areas contributing to runoff, likely focusing on impervious surface hotspots.

2. **Topography Analysis:** Use digital elevation tools like **USGS National Map Viewer**, **Google Earth Pro**, or **QGIS** to examine the slope and identify low-lying areas that might collect runoff.

3. **Identify Potential Sites:** Using the information they gathered on pervious and impervious surfaces and topography, students should select two prospective sites for a rain garden.

4. **Estimating Runoff Contribution:**
   a. For each potential rain garden site, determine the area that would naturally drain into it (i.e., where rainfall would flow toward the site). Use measurement tools available in digital elevation tools to trace and calculate this area

   b. Apply a simplified runoff coefficient for different surfaces to estimate how much water the rain garden would likely need to handle.

DAY 4: WEATHER DATA AND CALCULATING RAIN GARDEN SIZE

Objective: Students will analyze weather data and use previous contributing area calculations to determine the volume of water their rain garden should be able to collect.

Activities

1. **Analyzing Weather Data:**
   a. Following the provided guidance, gather local rainfall data (e.g., **NOAA Climate Data Online**, **Weather Underground**).

   b. Analyze the data to determine average precipitation and storm events, and extreme rainfall scenarios

   c. Discuss patterns in the data.

2. **Rain Garden Volume Calculation:** Guide students through calculating runoff volume based on previous runoff area contribution estimation and rainfall data.

DAY 5: SOIL ANALYSIS FOR RAIN GARDEN DESIGN

Objective: Students will explore properties of soils, like texture, infiltration, and compaction to assess their suitability for a rain garden.

Activities

1. **Hands-On Soil Testing:**
   - **a.** Conduct soil texture analysis (sand, silt, clay) using collected soil samples.
   - **b.** Conduct percolation tests in the field to determine how quickly water drains into the ground at proposed rain garden sites.

2. **Class Discussion:**
   - How do soil properties affect water infiltration?
   - What modifications might improve site suitability?

3. **Explore Soil Maps:** Visit NRCS' **Web Soil Survey** and collect soil maps of the area. Consider how the collected field data compares to the publicly available data.

DAY 6*: DESIGNING THE RAIN GARDEN

Objective: Students will integrate their findings to design a rain garden tailored to their schoolyard.

Activities

1. **Design Workshop:**
   - **a.** Students use their data about land cover, topography, rainfall, and soil to draft rain garden designs.
   - **b.** Encourage them to include key elements: location, size, depth, and plant selection.
   - **c.** Students should price out their design (e.g., the cost of the plants they're suggesting be used).

2. **Presentation:**
   - **a.** Students briefly present their designs to the class. Potentially bring in a professional, such as someone from the local Soil and Water Conservation District, to listen to student designs and ask (and answer) questions from students.
   - **b.** Conduct a peer review to evaluate designs based on feasibility, effectiveness, aesthetics, and cost.

**Depending on how much class time you want to dedicate to the design and student presentations, this component could span multiple days.*