Down Came the Rain: Roofs and Runoff

Objective: To determine the volume of runoff from a school or home roof. Roof area will be estimated using Google Earth aerial imagery, and online precipitation data will be downloaded from climate data sites.

Selected National and State Standards:

National Science Education Standards
Unifying Concepts & Processes; Standard A - Science as Inquiry; Standard D - Earth & Space Science; Standard E - Science & Technology; Standard F - Science in Personal and Social Perspectives

National Council of Teachers of Mathematics Standards
Numbers & Operations: 6-8; Algebra: 6-8; Geometry: 6-8; Measurement: 6-8; Problem Solving: 6-8; Communication: 6-8; Connections 6-8

National Educational Technology Standards
Standard 1 - Creativity and Innovation; Standard 2 - Communication and Collaboration; Standard 3 - Research and Information Fluency; Standard 4 - Critical Thinking, Problem Solving, and Decision Making; Standard 6 - Technology Operations and Concepts

AP Environmental Science Focal Areas
Humans alter natural systems; Environmental problems have a cultural and social context; Human survival depends on developing practices that will achieve sustainable systems
**Virginia Standards of Learning**

Science: 6.7, 6.9, E.S.1, ES.2, ES.3, ES.7, ES.9, ES.13

Mathematics: 6.6, 6.7, 6.10, 6.18, 7.3, 7.4, 7.5, 7.14, 8.3, 8.7, 8.11

Computer/Technology: 6-8.1, 6-8.5, 6-8.6, 6-8.7, 6-8.8

**Maryland State Curriculum (Grade 6-8)**


**Background:** Runoff occurs when water from precipitation flows over land instead of soaking into the ground. Runoff is a component of the water cycle. Natural areas tend to absorb more rainwater and have less runoff than manmade areas. When humans replace natural areas, such as forests, with impervious surfaces, such as buildings and roads, we impact the water cycle by creating excessive runoff. As runoff moves along the ground, it can pick up oil, pesticides, and fertilizers. Runoff containing pollutants is called non-point source pollution. Even the roofs of our buildings can be sources of heavy metals, weatherproofing chemicals, pathogens that cause disease, pesticides that kill insects, and herbicides that prevent plant growth. Polluted runoff can move into drinking water sources, such as groundwater, streams, and rivers. In this activity, we will estimate the volume of runoff from our roof. We will measure our roof using Google Earth and download online precipitation data. We will use the equation V=ARC, where runoff volume (V) is determined by finding roof area (A) times the amount of precipitation (R); we will convert units (C) to find runoff in gallons. (C = Conversion Factor: 7.48 gal/ft³).

**Materials:**

- Computers with Internet access and Google Earth installed
- Google Earth is a free download available from www.google.com/earth.
- Calculators
Procedure:

1. Class discussion
   a. What is runoff?
   b. Describe some outdoor areas that would absorb rainwater. (Ex. Wetlands, forests, and to a lesser extent lawns.)
   c. Describe some outdoor areas that would cause runoff. (Ex. Hard, impervious surfaces, such as paved areas, roads and buildings.)
   d. Why is runoff a problem?

2. Find the area of the building roof in square feet.
   a. Open the Google Earth application.
   b. Search for your school or home by typing your school name or address in the “Fly to” box.
   c. Click the ruler icon on the top toolbar to open the ruler tool. Set the units to feet.
   d. Use the ruler tool to measure the length of the roof. Record the measurement.
   e. Use the ruler to measure width of the roof and record.

3. Calculate the area of the roof. (Note: Many roofs are not in the shape of a perfect rectangle. The roof shape can often be broken down into smaller rectangles. To find the total roof area, sum the areas of the smaller rectangles.)
   
   Variation: Obtain blueprints of your school and have students calculate roof area.

4. Find R, the amount of rain in feet.
   a. Download local precipitation data online. (Note that most sites display precipitation in inches, which must be converted to feet.)
   b. Suggested sites:
   
   Variation: Monitor a rain gauge or use the value for your area’s long-term average precipitation
5. Determine \( V \), the volume of runoff in gallons. You found \( A \), the area of the roof in square feet and \( R \), the amount of rain the roof receives in feet. The conversion factor, \( C \), \((C = 7.48 \text{ gal/ft}^3)\) will convert cubic feet to gallons. Use the equation \( V = ARC \) to determine how many gallons of runoff your roof produces.

**Observations & Conclusions:**

1. What types of contaminants might be present in your roof runoff?
2. Are there contaminants that might come from regional sources? (E.g. Factories in the area may deposit smoke, smut, and chemicals on roof tops.)
3. What are some ways that runoff might affect your local environment? How could runoff affect your watershed?
4. What potential actions could reduce runoff from your roof?

**Extensions:**

1. Compare the amount of runoff in a day, month, and year. Determine if runoff is greatest in a particular season.
2. Determine the amount of runoff from parking lots, hardtops, and other impervious surfaces at your school.
3. Determine the number and locations of outflows that remove water from the roof. Investigate the vegetation in these areas.
4. Measure the volume of runoff from the roof using 5 gallon buckets.
5. Use Google Earth aerial imagery to identify manmade runoff zones in your area. (Impervious urban areas are gray in color.)
7. Research the quality of local drinking water at http://www.ewg.org/tap-water/home
Green Jobs:

The Bureau of Labor Statistics (http://www.bls.gov/green/) defines green jobs as:

“Jobs in businesses that produce goods or provide services that benefit the environment or conserve natural resources.” And “Jobs in which workers’ duties involve making their establishment’s production processes more environmentally friendly or use fewer natural resources.”

1. Have students investigate the types of jobs are suited to their personality, skills and interests by using these online resources. The personality test center helps identify career options based on personality indicators and the O*NET tool uses interests and skills to suggest potential careers. Students can choose to use both tools and compare the results or use each tool individually.

   a. Personality Career Tool Activity: Complete your Meyers Briggs type indicator at the online site.
      i. Go to www.personalitytest.net/cgi-bin/q.pl
      ii. Answer the 68 quick “either/or” questions. Choose your best answer to each question.
      iii. When you click “RESULTS” your personality type will be listed.
      iv. With your four letter reference type, choose an occupation from the list that might help suit your type and is a job that you might be interested in exploring.
      v. The listing can be found by clicking “Green Jobs List” at http://www.ctenergyeducation.com/greenjobs.htm
      vi. Do a web search of the listed resource sites and other sites to find out more about the job you chose.
          • What training/background is required?
          • What is the entry-level pay or average pay for this occupation?
          • Do there seem to be any jobs available in this occupation? If so where are they?
          • After completing your research are you more or less interested in this occupation that when you started? Explain why.

   b. O*NET Interest Profiler Activity: Complete the O*NET Interest Profiler
      i. Go to http://www.mynextmove.org/explore/ip and complete the interest profiler
      ii. Answer the quick 60 questions with your best answers for each question.
      iii. When you have finished your interests will be shown in a graph, click Next to see the jobs suited to your interests.
iv. For the jobs listed, choose ones you are interested in.

- What training/background is required?
- What is the entry-level pay or average pay for this occupation?
- Do there seem to be any jobs available in this occupation? If so where are they?
- After completing your research are you more or less interested in this occupation that when you started? Explain why.

2. Have the students investigate green jobs related to runoff and stormwater management. Suggested resources:

   http://www.bls.gov/green/greencareers.htm

   http://www.wowonline.org/green_members/documents/StormwaterFinalPPT.pdf

Service-learning Projects:

Have students design a service-learning project implementing a green solution at your school or in your community.

1. Local rain barrel workshops are often free or low cost to teachers. Involve the art class and shop class in building and decorating your rain barrel.

2. Create a rain garden with water-loving plants, measure plant growth, and monitor the animals that colonize your green space.

3. Get the students excited about educating their classmates, parents, and community about green solutions.

To learn more about service-learning visit www.servicelearning.vcu.edu and http://www.servicelearning.org/what-service-learning.
**Objective:** To determine the volume of runoff from a school or home roof. Roof area will be estimated using Google Earth aerial imagery, and online precipitation data will be downloaded. Runoff volume will be determined using the following equation.

\[ V = ARC \]

- \( V \) = volume of runoff (gal)
- \( A \) = area of roof (ft\(^2\))
- \( R \) = amount of rain (ft)
- \( C \) = Conversion Factor: 7.48 gal/ft\(^3\)

**Procedure:**

1. Find the area of the building roof in square feet.
   a. Open the Google Earth application.
   b. Search for your school or home by typing your school name or address in the “Fly to” box.
   c. Click the ruler icon on the top toolbar to open the ruler tool. Set the units to feet.
   d. Use the ruler tool to measure the length of the roof. Record the measurement.
   e. Use the ruler to measure width of the roof and record.
2. Calculate the area of the roof. (Note: Many roofs are not in the shape of a perfect rectangle. The roof shape can often be broken down into smaller rectangles. To find the total roof area, sum the areas of the smaller rectangles.)

\[
\text{Length} \times \text{Width} = \text{Total Area of Roof}
\]

3. Find R, the amount of rain in feet.
   
   a. Download local precipitation data online. (Note that most sites display precipitation in inches, which must be converted to feet.)
   
   b. Suggested sites:
      
      

4. Determine V, the volume of runoff in gallons. You found A, the area of the roof in square feet and R, the amount of rain the roof receives in feet. The conversion factor C will convert cubic feet to gallons. Use the equation \( V = ARC \) to determine how many gallons of runoff your roof produces.

\[
V = ARC
\]

\[
A = \underline{\text{______________}}
\]

\[
R = \underline{\text{______________}}
\]

\[
C = \underline{\text{______________}}
\]

Solve for V.
Observations and Conclusions:

1) What types of contaminants might be present in your roof runoff? Are there contaminants that might come from regional sources? (E.g. Factories in the area may deposit smoke, smut, and chemicals on roof tops.)

2) What are some ways that runoff might affect your local environment? How could runoff affect your watershed?

3) What potential actions could reduce runoff from your roof?
Down Came the Rain: Roofs and Runoff

Name _____________________________________________

Part 1: Open Google Earth and fly to your home address.
1. Use the ruler to measure your roof length in feet. ____________ ft
2. Use the ruler to measure your roof width in feet. ____________ ft
3. Calculate your roof area. (Area = Length x Width) ____________ ft²

My roof has an area of ____________ square feet.

Part 2: Look at the precipitation table provided.
1. How many inches of precipitation fell on your roof in February 2012? ____________ inches
2. Convert the amount of precipitation from inches to feet.
   1 foot = 12 inches
   ____________ inches x (1 foot / 12 inches) = ____________ feet

My roof received ____________ feet of rain in February 2012.
**Part 3:** Calculate the amount of runoff from your roof.

Runoff = area of roof x amount of rain x 7.84 gal/ ft³

Runoff = __________ ft² x __________ ft x 7.48 gal/ft³  

Runoff = __________ gallons

My roof created __________ gallons of runoff in February 2012.

**Part 4:** If it rained about 4.5 feet in 2011. Calculate the amount of runoff for all of 2011!

Runoff = area of roof x amount of rain x 7.84 gal/ ft³

Runoff = __________ ft² x __________ ft x 7.48 gal/ft³  

Runoff = __________ gallons

My roof created __________ gallons of runoff in 2011.
<table>
<thead>
<tr>
<th>Date</th>
<th>Precipitation</th>
<th>Temperature</th>
<th>Wind Speed</th>
<th>Humidity</th>
<th>Sunshine</th>
<th>Relative Humidity</th>
</tr>
</thead>
<tbody>
<tr>
<td>01-01-2023</td>
<td>0.5 mm</td>
<td>15°C</td>
<td>10 mph</td>
<td>50%</td>
<td>5 hours</td>
<td>70%</td>
</tr>
<tr>
<td>01-02-2023</td>
<td>1.2 mm</td>
<td>13°C</td>
<td>15 mph</td>
<td>60%</td>
<td>4 hours</td>
<td>80%</td>
</tr>
<tr>
<td>01-03-2023</td>
<td>0.8 mm</td>
<td>14°C</td>
<td>12 mph</td>
<td>45%</td>
<td>6 hours</td>
<td>65%</td>
</tr>
<tr>
<td>01-04-2023</td>
<td>2.0 mm</td>
<td>12°C</td>
<td>20 mph</td>
<td>70%</td>
<td>3 hours</td>
<td>90%</td>
</tr>
<tr>
<td>01-05-2023</td>
<td>1.5 mm</td>
<td>16°C</td>
<td>18 mph</td>
<td>55%</td>
<td>7 hours</td>
<td>75%</td>
</tr>
</tbody>
</table>

Note: Precipitation values are measured in millimeters (mm). Temperature is given in degrees Celsius (°C). Wind speed is in miles per hour (mph). Humidity values are percentages. Sunshine values are in hours. Relative humidity values are percentages.
Solar Energy

What

Solar energy is the radiant energy (light, heat and other types of radiation) that is produced by the sun. Humans use solar energy in a variety of ways, including heating, electricity production and cooking. Solar technology is divided into two categories, passive or active.

- Passive solar technology utilizes things like building design, materials and placement to use the sun’s energy to provide light and heat. For example, skylights can be installed so that sunlight can light a room.
- Active solar technology uses photovoltaic cells and solar thermal collectors to collect and use the sun’s energy.
  - Photovoltaic cells, or solar panels, are made of semiconductor materials similar to that found in computer chips. When sunlight hits the semiconductor electrons are released and electricity is generated.
  - Solar thermal collectors absorb the energy from sunlight and convert it into heat which be used to heat water and to generate electricity.

So What

Solar energy is the most abundant source of energy available to us with over 170,000 terawatts of solar energy continuously striking the Earth. That's more than 10,000 times the world’s total energy use but, currently, solar energy technology produces less than one tenth of one percent of global energy demand. One of the factors limiting the use of solar energy is cost. It is more expensive to produce energy through solar technology than is to produce energy from conventional sources. However, advances in solar technology has increased efficiency and lowered costs. Solar energy usage has increased by about 20 percent a year over the past 15 years.
Solar energy is a renewable source of energy. The use of solar energy helps to reduce our dependence on non-renewable energy resources, such as petroleum and natural gas. Another advantage of solar energy usage is that it does not produce pollutants like carbon dioxide and other greenhouse gas. It also does not contribute to noise pollution. Solar technology is a major part of the “green” economy and can be utilized in both small- and large-scale applications. There are a variety of grants and incentives available to assist homeowners, schools, and businesses with the purchase and installation of solar technology.

**Now What**

Solar energy and solar technology can be incorporated in a variety of Service-learning opportunities. Students can work with organizations such as Habitat for Humanity to encourage the inclusion of solar elements in both new construction and renovations. They can assist homeowners by providing information on solar technology options and financial assistance programs.

Students can design or retrofit school projects, such as gardens and bioretention ponds, to replace conventionally powered lights, filters, and pumps with ones that use solar energy. They can also work with school administration to install solar thermal collectors, photovoltaic panels or items such as solar-powered trash compacters to help reduce the school’s conventional energy usage. Students can participate in challenges, such as the Junior Solar Sprint, to design and build solar-powered devices and share what they have learned with younger students.

For more information about solar energy, visit:

http://www.need.org/needpdf/infobook_activities/ElemInfo/SolarE.pdf
http://www.nrel.gov/education/jss_hfc.html
http://www.eia.gov/kids/energy.cfm?page=solar_home-basics
http://www.eere.energy.gov/basics/renewable_energy/solar_resources.html
http://www.solardecathlon.gov/education.html
http://www.solardecathlon.gov/curriculum.html
Environmental Investigation and Service Learning

Unit Overview

This course will focus on watershed ecology in the Chesapeake Bay area, more specifically, Fredericksburg and the Rappahannock River. Students will learn about the health of the local watershed using water chemistry data and macroinvertebrate surveys. They will learn what the acceptable ranges of temperature, pH, dissolved oxygen, and other metrics are for the local streams and rivers to determine their general health. They will work on projects that are geared toward keeping the local waterways clear of litter and restoring an area of riparian buffer zone in partnership with Friends of the Rappahannock.

Unit Context

The unit begins with general team building activities and lessons on service learning. Throughout the unit there will be reviews of their basic knowledge of watersheds from their 6th grade science class (SOL 6.7--the health of ecosystems and the abiotic factors of a watershed, major conservation, health, and safety issues associated with watersheds; and water monitoring and analysis using field equipment including hand-held technology). Students will learn to collect and interpret water chemistry data using Labquest probeware. Lessons on the major aquatic macroinvertebrate species of our local areas will introduce students to the concept of using biotic data to interpret the health of the areas tested. Discussion will include how and what the impacts are of the community on the watershed. There will be lessons on green jobs and those careers that are responsible for providing clean water from source to consumer. Essential questions this unit will address are:

What is MY impact on the water source in this community?
What can I do to improve water quality in my community?
How can I influence others of the importance of water conservation and health?
Learners Involved

The Environmental Investigation and Service Learning class includes 7th and 8th graders with a cross-section of backgrounds and abilities. 6th grade students will be recruited for the spring service projects.

Standards & Goals

Service-Learning Standards

Duration & Intensity
The lessons will take place 2-3 times per week throughout the school year during part of an elective block for 7th and 8th graders. There will be two field trips to Friend of the Rappahannock in Fredericksburg that will last the entire school day.

Meaningful Service
Students will take part in service to the community by planning and carrying out service projects related to the health of the local watershed area. They will contact our partner, Friends of the Rappahannock, to set up a river cleanup project in which they will plan, advertise, recruit volunteers, gather supplies, and carry out. They will participate in Friends of the Rappahannock’s big spring River Cleanup in April where they will have a tent with activities for volunteers and their children. They will also participate in a restoration project for a riparian buffer zone with Friends of the Rappahannock and a local high school. The 7th and 8th grade students will educate the 6th grade students and involve them in the restoration project. A select group of these 6th graders will continue the project next school year along with students who move to the 8th grade next year.

Links to Curriculum
The unit is aligned to the Virginia Standards of Learning in 6th grade science (watershed ecology), math (data collection, charts, and graphs), and technology (Labquest probeware). The unit will serve to enhance their experience with the material.

Youth Voice
Students in the class will choose projects that meet their interests within the environmental aspect of the course. They will be responsible for researching, planning, recruiting, and carrying out projects.

Partnerships
We are partnering with Friends of the Rappahannock, a non-profit conservation organization based in Fredericksburg, VA for education, guidance, and support for the service projects the students have begun. Internal partnerships include administration, teachers, and parents of students at our school.

Diversity
The students working on the project are at different grade levels (7th-8th and 6th graders participating in the spring). The students also have diverse backgrounds that bring a variety of viewpoints regarding the importance of water conservation and the relevance of watersheds in their communities. The students have a spectrum of strengths that are emerging thorough activities and finding and using “student voice”.

Reflection
Reflection activities will include whole class discussions, small group discussions, and discussion board postings on our school’s Blackboard-like web platform for our class. Discussions about improving our projects will be especially important throughout the year. Student surveys will be used to get feedback and to gauge interest from students.

Assessing Impacts
Students will be the driving force behind assessing the impacts they have made. We will use reflections and group discussions to decide what worked and what didn’t work. Friends of the Rappahannock will also offer feedback to the students and teacher about how the project can be improved. Students will note how aspects of the project could be improved upon next year.

Sharing & Celebrating
Students will share their experiences with the school and community through the school’s weekly e-newsletter, BanditBytes, and on a web page they will create through Glogster. Students will celebrate at the end of the year with a picnic by the Rappahannock River.

Learning-Service Goals

Civic Knowledge, Skills, Attitudes and Values
The civic goal for this project is to improve the health of the river and watershed by volunteering for clean up days and promoting others in the community to volunteer time to help with clean-ups and repairing the riparian buffer. Students will also have a deeper understanding of the importance of their watershed and the impact one person can have on it and share that understanding with community, family, and friends.

Character & Social Skills
Character and social skills are built upon as students contact members of the community to set up clean up days, interact with administration in the building and other adults to get their goals accomplished. Students will gain skills in problem solving and working cooperatively in large and small groups.

Career Skills
As students learn how test the river’s water quality, build a website and get involved with their community they will be exposed to career paths they can take.

Academic Engagement
This unit engages students academically by getting them involved in a cause they have chosen. In 6th grade students learn about watersheds and their importance and in this course that will put into practice the standards they have already learned. When new lessons are taught students will be engaged so that they can put into practice and use the information they are learning. Friends of the Rappahannock will teach the students about water conservation and the students can then take the knowledge gained and work on water conservation in their own homes and see positive outcomes.
Assessment Plan

Student Progress
This is a non-graded elective class for the students which will not be reflected on their report cards. Reflections on successfully completed projects are used to assess whether students have made progress.

Impact on the Community
Students will assess the measure of success of their project in relation to the community by creating an online survey to see if their families and friends attitudes and behaviors have changed based on their involvement in the project. A similar survey can be created to assess the impact on school community, specifically the 6th grade.

Impact on Partners
Students will contact Friends of the Rappahannock and discuss their outcomes in comparison to similar projects. They will then write a reflection piece and share those reflections in small groups to see if other students working on the project have similar impressions of the success in working with Friends of the Rappahannock. Students can then brainstorm other possible partners for next year or talk about how they can improve the partnership to achieve a higher level of success next year.

Unit Lesson Plans

Part 1—Teaching students about the global/national impact of the issue
Our students learn about watersheds in the 6th grade science curriculum. We will review the topic in a mini-unit using several lessons on water chemistry and watersheds from various resources.

Lesson 1: “Wetland Habitats”
Students will use flow charts to classify wetlands based on their characteristics given on a set of cards.

Standards of Learning:
National Science Education Standards: Systems, Order, and Organization, 2010 VA Science SOL’s: LS.5

Methods and Activities
Teacher will give background information about wetlands, using pictures as examples. Students will be given copies of the flowchart and a set of habitat cards. Teacher will show how to use the flow chart with one card. Students will then classify each habitat according to the flow chart. Using pictures from magazines, students should be able to classify the wetlands shown. Class will visit the created wetland on school’s property (retention pond) to determine they type of habitat it supports.

Materials/Resources/Partners:
“Wow! The Wonders of Wetlands” pg. 87-92
Copies of Flow chart and habitat cards pg. 89 (1/group of 3 students)
Magazine pictures of wetlands
Methods of Instruction:
Visual
Sorting

Lesson 2: “Google Earth Tour of the Rappahannock River”
Students will fly through the watershed on an interactive tour before visiting Friends of the Rappahannock.

Standards of Learning:
2010 VA Science SOL’s: 6.5, 6.7, LS.7, LS.10

Methods and Activities
Pairs of students will each get a copy of the worksheet and a computer with internet access. Students will access the Google Earth tour of the Rappahannock to answer questions listed.

Materials/Resources/Partners:
Computers with Internet access
Worksheets

Methods of Instruction:
Computer lab

Lesson 3: We All Live Downstream
Students will realize the impact that their activities have on their neighbors’ properties.

Standards of Learning Objectives:
2010 VA Science SOL’s: 6.5, 6.7

Methods and Activities
Each student will get a small white board and marker. They will draw their idea of their ideal river front property on white boards. When they all finish, the whiteboards will be lined up to show that they’re all linked on the river. Each activity on their property has some type of pollution associated with it (runoff from buildings and driveways, fertilizer from crops or farm animals, sediment from eroding river banks). Each type of pollution will have a different color token associated with it. Teacher will give students tokens depending on what they have on their property. Teacher will tell students the direction the river flows. Students will then be able to describe the impact their river activities have on their neighbor’s property downstream from them.

Materials/Resources/Partners:
Small white boards
Tokens (at least 3 different colors)
Dry erase markers

Methods of Instruction:
Hands-on
Discussion
Part 2—Teaching students about the local impact of the issue
Lesson: Water Quality and Protection

Lesson Description
We will take a mini-field trip to Friends of the Rappahannock in September. Students will perform both biological and chemical water quality tests. Biological tests include benthic macro invertebrate sampling; chemical tests include data collection via handheld digital probeware and traditional chemical tests.

Standards of Learning Objectives:
2010 VA Science SOL’s: 6.1, 6.5, 6.7, 6.9; LS.1, LS.4, LS.6, LS.8, LS.9, LS.10, LS.11

Methods and Activities
All provided by educators at Friends of the Rappahannock—students will identify various common macroinvertebrates using samples provided by the organization. They will test water quality using chemical tests for pH and dissolved oxygen. Probeware was used to test temperature, pH, dissolved oxygen, and turbidity.

Materials/Resources/Partners:
Friends of the Rappahannock

Methods of Instruction:
Field Trip
Hands on

Part 3—Teaching students to work successfully in groups
Lesson Description
We will use these activities to begin the class and throughout the year in order to allow students to get to know each other and learn to work with each other.

Standards of Learning Objectives: No official objectives listed. However, team building activities teach cooperation, negotiation, and the importance of both verbal and non-verbal communication.

Methods and Activities
Space Carriers (Cooperation, communication)
(Taken directly from “Give Forests a Hand” Leader Guide)
You need to prepare carriers in advance, one for each group of 8-10 people. Tie 4 or 5 three foot lengths of strings to a rubber band (four for eight people, five for ten). Break into groups of 8-10. Explain that cooperation and communication is crucial to the success of any group project and youth must use both just to move a single cup of water from one point to another. Each group forms a circle and everyone picks a partner. Blindfold one partner from each pair, and hand each blindfolded person one of the strings. Set a paper cup of water on the floor in the center of each group. Tell groups they have to use the carrier to pick up the cup, lift it off the ground without spilling any water and move it 20 feet to a designated spot. The blindfolded partner is the only one allowed to touch the string. The non-blindfolded partner can talk only to their blindfolded partner, and not to any other pairs. Give the groups five minutes to work. Do not tell them how to do the task. If they spill a little, say, "Oops! Careful," but keep going. If the cup tips over, have them start again; or stop and talk, depending on time and frustration levels. When one group succeeds or time runs out, take off blindfolds and discuss. Now, try again, letting pairs talk to each other or with one person directing the four blindfolded people. When participants pull on all strings equally, they can stretch...
the rubber band large enough to fit over the cup. When they slowly release the strings, the rubber band fits snugly around the cup so it can be lifted.

After completing the activity, lead a discussion using the following questions:

Was the task difficult? Why? Why not?
Was it harder when verbal communication was not allowed? How did you communicate?
How can we increase communication on our project?

Log Jam (Critical Thinking, Problem Solving, Communication)
(Taken directly from “Give Forests a Hand” Leader Guide) Procedure: Tape seven pieces of paper to the floor in a straight line. Have six youth stand on each numbered piece of paper. All participants should face the middle piece of paper. The youth to the left of the blank piece of paper are Team A (papers 1, 2, 3) and the youth to the right of the blank piece of paper are Team B (papers 4, 5, 6). The object of the activity is for the members of Team A to switch places with their counterparts of Team B. For example, Person 1 needs to end up where Person 4 was and vice versa. The two teams must work together to undo the log jam.

The rules are:

Everyone must be on a piece of paper at all times.
There can be only one person on a piece of paper at a time.
You can only move forward and only to an empty piece of paper.
You can go around one person at a time, only if there is an empty piece of paper behind them, and only if that person is on the other team.
After explaining the rules, answer any questions and then allow the game to begin.

After completing the activity, lead a discussion using the following questions:

Was the task difficult? Why or why not?
Did your group have a leader? How did this work?
Did everyone contribute to the solution? Why or why not?

To Share or Not to Share (Many groups coming together for one solution)
Procedure: Before starting this activity, make a copy of the task sheet for each group and be sure to have the materials needed to give out to each group.

Task List:
1. Make a paper airplane at least 20" long that flies.
2. Make a flag of 3" x 5" in at least three different colors.
3. Make a red hexagon with sides at least 2" long.
4. Make a paper chain of at least three different colors.
5. Make a cube of aluminum foil with sides 2" x 2" x 2".

Divide youth into 4 groups and pass out the appropriate materials to each group.

- Group 1: tape, 10 sheets of aluminum foil, 1 yellow sheet, 1 white sheet
- Group 2: tape, compass, 2 red sheets, 1 yellow sheet, · 1 white sheet
- Group 3: scissors, 1 white sheet, 2 blue sheets, 1 yellow sheet
- Group 4: glue, 1 blue sheet, 2 red sheets, ruler

Give each group a copy of the task sheet and explain that each group has a different set of materials but all groups must complete the same tasks. Between the four groups, there are enough materials for each group to complete all tasks, if materials are used appropriately. Groups are allowed to bargain for materials. Besides what is passed out at the beginning of the activity, absolutely no other materials are to be used.
other items in the room or items that youth may have with them. The first group to complete all tasks correctly is the winner.
Feel free to change the number of groups based on the number of youth you have. You will also have to adjust the materials given out and the tasks to be completed. The materials handed out to each group should be unequal but not so much so that one group feels completely helpless!
After completing the activity, lead a discussion using the following questions:
How did it feel not to have all the materials you needed?
How did groups cooperate, compete, and bargain to get what they needed?

Materials/Resources/Partners:
Activity Bank in “Give Forests a Hand” Leader Guide, pg. 43, 45, 48, 49
Space Carriers: Paper cups, 3 Rubber bands (just large enough to fit snugly around the cups), String, 4 –5 Blindfolds, Water
To Share or Not to Share:
Group 1: tape, 10 sheets of aluminum foil, 1 yellow sheet, 1 white sheet
Group 2: tape, compass, 2 red sheets, 1 yellow sheet, · 1 white sheet
Group 3: scissors, 1 white sheet, 2 blue sheets, 1 yellow sheet
Group 4: glue, 1 blue sheet, 2 red sheets, ruler

Methods of Instruction:
Cooperative Learning
Hands-on

Part 4—Guiding students to select a meaningful service project that addresses the environmental issue
Lesson 1 “What Can WE Do?”
Lesson Description
We will partner with Friends of the Rappahannock to create/maintain a riparian buffer zone along the Rappahannock in Fredericksburg, get involved with stream monitoring, and organize community clean-ups. Or, the students may want to do something in direct connection with our school. Recycling and composting programs are already in place; however, the composting program could be expanded and improved upon. The education director from Friends of the Rappahannock will visit the school for 2 lessons to teach students about conservation and restoration activities.

Standards of Learning Objectives:
2010 VA Science SOL’s: 6.1, 6.5, 6.7, 6.9; LS.1, LS.4, LS.6, LS.8, LS.9, LS.10, LS.11

Methods and Activities
Education Director from Friends of the Rappahannock will present “Livable Neighborhood Water Stewardship Program” —a Program of Global Action Plan in cooperation with Friends of the Rappahannock, the VA Dept. of Conservation and Recreation, and the National Fish and Wildlife Foundation. Students will learn about ways to reduce water usage in their homes. They will be given ideas to take to families in order to reduce usage and saving money. Students will be challenged to help reduce their family’s water bills with some of the activities in the booklet.

Materials/Resources/Partners:
Friends of the Rappahannock, Education Director
Methods of Instruction:
Guided/Direct Instruction

Part 5—Teaching students about green job opportunities
Lesson 1: “Green Career Cruising”
Students will complete a webquest/online scavenger hunt to discover what green jobs are and what
types of green jobs are available now.

Standards of Learning Objectives: No official objectives listed.

Methods and Activities
Teacher will start a discussion before the webquest to find out what students know about green jobs.
“Green job” will be defined. Students will brainstorm some ideas about what types of green jobs are
available. Students will work on their own to discover different types of jobs available now, education
required, salary, names of companies/organizations that hire people with these skills.

Materials/Resources/Partners:
http://ase.org/resources/green-careers-web-quest
Computer Lab
Webquest handouts

Methods of Instruction:
Computer lab

Lesson 2: “Wet-Work Shuffle”
Students will learn what jobs are responsible for getting water from its source to the tap and will
describe various water resource careers.

Standards of Learning Objectives: No official objectives listed.

Methods and Activities
Each group of students will be given a set of shuffled water career cards to arrange in what they think
is the best order. Ask each group to explain their pathways, comparing to other groups to discuss
whether or not the town will get its water. Show students the order on the original sheets in the book
to allow them to evaluate and make adjustments to their own sequences. Discuss other water-related
careers (fisheries specialist, meteorologist, marine biologist, navigator, educator, etc). Students may
then draw a diagram of the pathway from water source to tap, highlighting the professions responsible
for getting them from one to the other.

Materials/Resources/Partners:
Project Wet, pg. 360-364
set of water career cards for each group of students
butcher paper
markers
Methods of Instruction:
Hands-on
Guided learning
Organizing/Analysis

Lesson 3: “Want Ads”
Students will make a help wanted ad to create a job description based on a career they learned about in the webquest.

Standards of Learning Objectives: No official objectives listed.

Methods and Activities
Students will be shown a variety of want ads from the newspaper to give them an idea of how they are written. They will create a job description based write type up a “want ad” for that particular job. All want ads will be added to the class “paper” on one large piece of butcher paper.

Materials/Resources/Partners:
Connecting Thinking and Action: Ideas for Service-Learning Reflection “Want Ads” pg. 61
http://www.servicelearning.org/library/resource/5636
Newspaper Want Ads.
Butcher paper

Methods of Instruction:
Guided instruction
Hands-on

Additional Resources
Wow! The Wonders of Wetlands An Educator’s Guide
Environmental Concern Inc. 2003
Project Wet Curriculum and Activity Guide
The Watercourse 1995
“Give Forests a Hand” Leader Guide
University of Florida School of Forest Resources and Conservation 2006

Partner
Friends of the Rappahannock
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