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# Score Four:

## Students, Schools, Streams, and the Bay



Students doing real-world science and math, campus environmental investigations, and sustainable stormwater projects to improve the quality of their streams, communities, and the Chesapeake Bay.

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**The Interstate Commission on the Potomac River Basin**





The gardens and trees we plant are just the beginning. Students are putting down roots for healthy streams, cleaner air, beautiful spaces, wildlife habitat, and life-long stewardship.

The Interstate Commission on the Potomac River Basin (ICPRB) developed the lessons in the *Score Four Program* in partnership with the Elms Environmental Education Center and the Science, Technology, Engineering and Mathematics Program of St. Mary's County Public Schools, and the support of multiple authors. We thank Kenmoor Middle School, Prince Georges County Public Schools, for enabling us to pilot the *Score Four Program* with their students, 2014-2015.

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# Table of Contents

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Each section of this notebook represents a step in planning and developing your Student Stormwater Action Project. The binder has room for your field notes, research results, drawings, and photos.

## The Process:

### A. Exploring Your Watershed

- FieldScope Map Inquiry
- Topography, Land Use, and Stormwater Chemistry

In **Exploring Your Watershed** you learn about your local waters, pollution sources, and possible solutions for stormwater pollution.

### B. Assessing Your Campus

- Permeability Prediction
- Permeability Field Investigation
- Campus Assessment
- Soil Components: It's Not Just Dirt
- Soils Percolation Investigation

In **Assessing Your Campus** you discover how your school grounds contribute to stormwater pollution.

### C. Planning Your Project

- Project Goals
- Site Selection
- Sun/Shade Observation
- Site Characteristics and Plant Preferences
- Plant Selection and Garden Design

In **Planning Your Project** you investigate factors that affect the growth and success of gardens and trees. You also set goals for your Stormwater Action Project, pick the site, select appropriate native plants, and design the garden or forest.

### D. Maintaining your Project

**Maintenance** is about making sure that your plants and trees continue to meet your classes' goals for years to come. Maintenance is so important, it gets its own section.

### E. Resources

**Resources:** Perhaps, you might want to undertake another stormwater-reduction project. You can explore this section to learn about other options, such as rain gardens.



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# Exploring Your Watershed

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**Score Four: Students, Schools, Streams, and the Bay**

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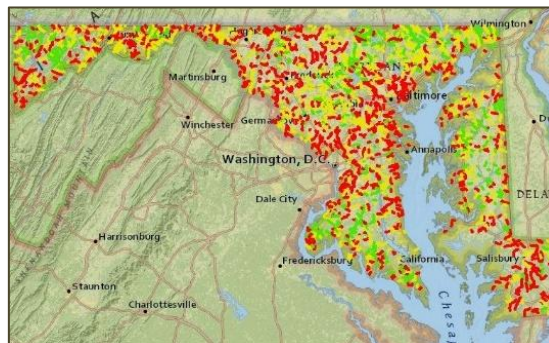


## Background

FieldScope is an online mapping program students can use to analyze and share environmental data about their school's watershed or an adopted stream. As a *geographic information system* (GIS), FieldScope enables users to view different types of data (such as population density or land cover) at the same time on one map.

You will use FieldScope to explore the following features near your school:

- Watersheds
- Rivers and streams
- Land cover
- Impervious surfaces
- Watershed or Stream health



The instructions for this activity are divided into two parts:

Part One: FieldScope Basics

- Learn how to make a map and use the FieldScope tools needed for Part 2.

Part Two: Explore Your Watershed

- Explore and analyze different aspects of your watershed using map data layers.

## Part One: FieldScope Basics

1. If you are in Maryland, go to <http://maryland.fieldscope.org/>. If you live in a different jurisdiction in the Chesapeake Bay Watershed, go to <http://chesapeake.fieldscope.org>.
2. Click on **"Map Data."**
3. Click on **"Create Your Own Map."**
4. **Selecting a Base Map**

A *base map* is the bottom layer of your map. (Other map layers with physical, geographic, or observational data are layered onto the base map, giving users the ability to observe possible relationships.) FieldScope offers choices of base maps with different views, place names, color schemes, etc.

- *Suggested choices for your base map: Topographic, National Geographic, or Street Map.*

When done, go to the next step one of these ways:

- Go to the *navigation bar near the top* of the screen titled "Create Map Progress," and click the next step in the sequence: **"2. Observation Data."**
- OR, click **"Next"** at the bottom of the screen.

## 5. Selecting Observation Data

The “Select Observation Data” page offers choices of data to view on your map. For instance, you can view stream data from the U.S. Geological Survey, schools, or citizen organizations.

*In this exercise, we will not use specific stream data, so **deselect** the “Participant Water Quality Data” box.*

Go to the next step by using the map navigator bar (*Step 3*), or by clicking on “Next.”

## 6. Setting Data Display.

“Select Data Display” enables users to change how observation data is displayed on a map. Take a moment to look at the options.

*Make no changes for this exercise.*

Click on “4 Map Layers” or “Next.”

## 7. Selecting Map Layers.

With “Select Map Layers” you can select the type of data layers to view. **Up to 2 layers can be selected at a time.** The layers can be changed easily later.

*While learning to use tools, you will use one map layer. Select Watersheds.*

Click on “5 View Map” or “Next.”

- A pop-up will appear. For now, click on “No, Thanks. I want to explore on my own.”

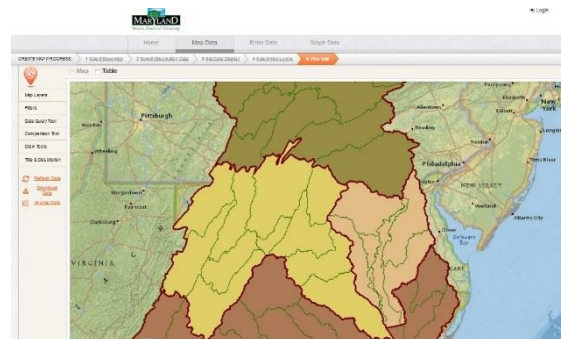
## 8. Viewing Your Map.

Now, you will see your map. It might not look as expected, because the Watershed data layer is blocking the view of the base map.

? What watershed is represented by this layer?

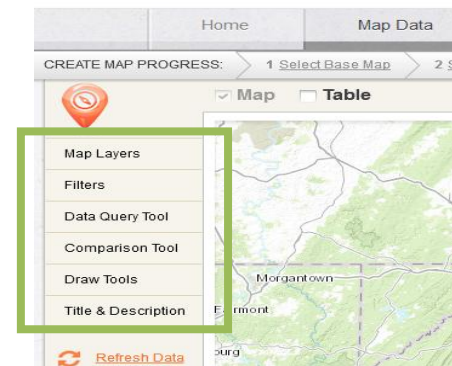
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Next, you will learn to use tools that enable you to adjust this view and use the map for research.



## 9. Using the Map Layer Tool

**FieldScope Tools** are located on the left side of the computer screen. You will use the Map Layers tool to adjust the visibility of your map layers. The data and base maps also can be changed with this tool.



*Click on Map Layers.*

- The top row controls the view of observational data. For now, it is inactive, as we did not include observational data.
- The second row shows the watershed map layer.
- The third shows your base map.

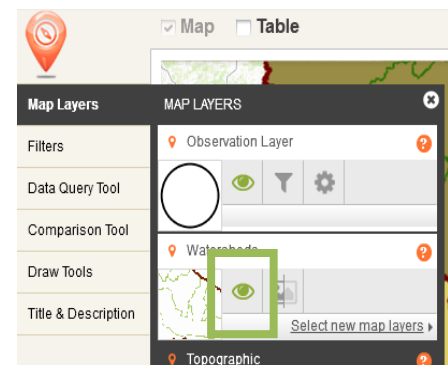
By using the **EYE** and **the slider bar** you can change the **visibility** and **transparency** of the layers of your map, respectively.

*Click on **the EYE**, the visibility tool, on the Watersheds layer.*

? What happens?

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Make the watersheds map visible again, using the EYE.



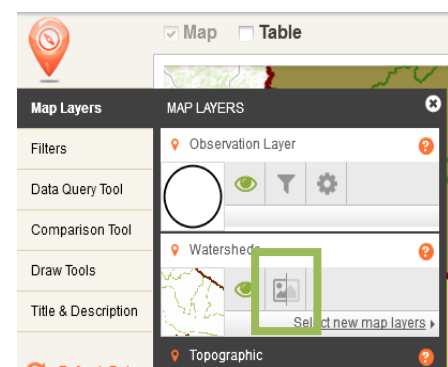
**Transparency** controls how much you can see through the layer. At 0% transparency, the layer is opaque. When new layers are added to a map, they initially are set to 0% transparency.

? *What happens when you slide the transparency bar to 100%?*

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? *Move the transparency bar until you can see both map layers. What percentage works for you?*

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## 10. Using the Draw Tools

The Draw Tool Box allows you to insert text, shapes, and lines on your map and to explore data more closely.

Click on **Draw Tools**. Hover over each tool with your mouse to see what it does.

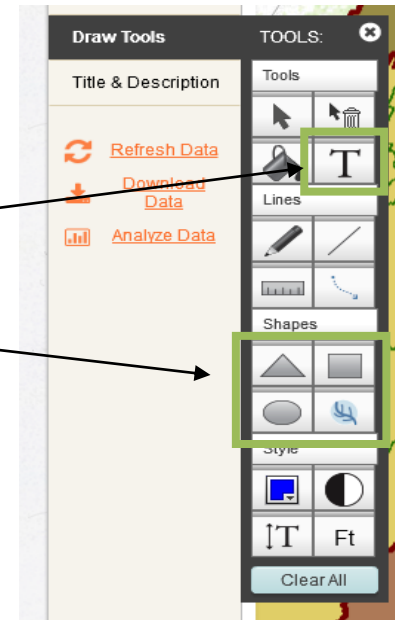
? Which tool can be used to measure distances on you map?

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You will use more of these tools in Part Two.

Insert  
text &  
labels

Insert  
shapes



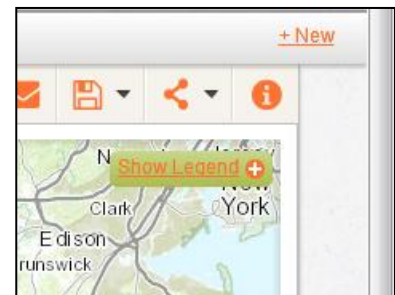
## 11. Using the Legend

In the top right corner of your map, is a “Show Legend” link. A legend lists what the symbols and colors mean on your map.

Click on “**Show Legend.**”

? List the largest subwatersheds in the Chesapeake Bay Watershed:

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## 12. Using the Search and Zoom Features

You can search for a location by clicking on the search tool — the magnifying glass — at the bottom right of your screen. The zoom tool (+ and -) is below the search tool.

Click on the search tool and enter the name of the city in which you live. Use the zoom to get a closer view of your neighborhood.

? What happens when you close the search tool?

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## Part Two: Explore Your Watershed

You are now ready to observe:

- Your school's watershed
- Local rivers & streams
- Land cover
- Impervious surfaces
- Impermeability
- Watershed health

### 1. Locate Your School

- Use the search button (magnifying glass) to locate your school. Put in the address or name of your school. The location will appear as a red dot. Keep the search tool open.
- Zoom all the way into your campus.

### 2. Creating a Marker and Label for Your School

Remember that when the search tool is closed, the red location marker disappears. You will create a school Place Marker and Label, which will remain in place as the view is changed.

#### *Making the Marker*

- Go to the TOOL BOX on the left side of the screen and open DRAW TOOLS.
- Click on the **Circle Tool**.
  - Press down on the map where you want the symbol and gently drag outwards to create a circle. Then LET GO. (If you press down too long without moving the cursor, the tool will automatically create a shape.)
  - If you are unsatisfied with your shape or its location, use:
    - The Select Tool to move it, or
    - The Erase Tool to delete it.

#### *Making the Label*

- Click on the **"Add Label"** tool.
- Click where you want to place the text and type it in.

Close the draw and search tools. Zoom out to see the results.

### 3. Locating Your Local Watershed

The Chesapeake Bay Watershed consists of large and small watersheds. To learn in which large and small watersheds (subwatersheds) the school is located, click on the school's location. A popup will appear.

? In what Small Watershed is your school located? \_\_\_\_\_

? What does this tell you about where stormwater runoff from your campus eventually flows?

\_\_\_\_\_

## 4. Viewing Nearby Rivers and Streams

*To observe small, nearby waterways, you will add the Rivers and Streams layer to your map.*

- Click on “4 **Select Map Layers**” on the top bar.
- Check the “**Rivers and Streams**” box to add it to your map.
- Click “**Next**” to view your map.
- Make sure you are zoomed in enough to see what streams are in your watershed and around your school.
- Click on the stream that nearest your school to see more information.

? Does the stream have a name? If so, what is it? \_\_\_\_\_

? Use the Measure Tool (in the Map Layers tool box) to measure how far the stream is from your campus. What did you get? \_\_\_\_\_

? One way to tell which direction the stream is flowing, is to find where it joins a larger stream or river. What river does your stream flow into? \_\_\_\_\_

## 5. Land Cover Layer.

*Now you will observe Land Cover on your map. This layer will show you the physical material on the surface of the earth, such as grass, asphalt, trees, bare ground, and water.*

Click on “4 **Select Map Layers**” on the top bar. Uncheck Watershed Layers. Add the “**Land Cover**” layer. Return to your map.

- Adjust the *transparency* settings (the slide bar) so that you can view land use, as well as the streams and base map.
- Show the legend, if it isn’t showing. Hover over the question mark by Land Cover.

? How recent is the data on this map? \_\_\_\_\_

- Click on any location to see what the land cover type is.

? What types of land cover are in the area surrounding the stream nearest your school?

\_\_\_\_\_

? Draw a square mile around the stream nearest your school, including your campus, if possible. (See measuring tool.) Which type of land cover is most common within that area?

\_\_\_\_\_

? Drawing a square around the stream isn’t the correct way to determine a stream’s watershed, but for this exercise we will assume that the area within your square drains to



you local stream. How do you think the stream health is affected by the runoff from the nearby land cover?

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6. **Impervious Surfaces Layer.**

*Now you will observe the Impervious Surfaces layer on your map. Impervious surfaces are areas cannot absorb or allow water to soak into the ground. This layer shows areas that are completely impervious to water versus those where at least some water soaks in. You will be able to view areas that have been categorized as impervious and pervious.*

To add the “**Impervious Surfaces**” layer to your map:

- Click on “**Select Map Layers**”
- Uncheck the “**Rivers and Streams**” layer box to remove it from your map.
- Check the “**Impervious Surfaces**” layer box to add it to your map.
- View your map, and adjust the transparency and zoom, as needed.
- Click on any location to see if the surface is categorized as impervious or pervious. If it is impervious, you will see a number 1 in the bottom right-hand of the information box. If it is pervious, you will see a 0.

? Generally, where do you find the greatest amount of impervious surfaces?

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? How do you think the stream health is affected by the amount of impervious surfaces in your watershed?

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? What are possible ways your class could verify the impermeability of different areas of your campus (known as, “ground truthing”)?

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? Why might it be necessary to “ground truth” the map data?

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7. **Bringing it all together: make a hypothesis about the health of the stream ecosystem nearest your school.**

- ? Consider the map data you have observed and what you have learned about the relationships of different land uses to stream health. Make a hypothesis about the health of your stream, based on the types of land uses and/or cover you observed in the area draining to your stream. You could state that the stream health is good, fair, or poor, based on your reasons; or you could pick a specific feature, such as the amount of erosion or aquatic life you expect

on the stream. (Info on making a hypothesis: [http://www.sciencebuddies.org/science-fair-projects/project\\_hypothesis.shtml](http://www.sciencebuddies.org/science-fair-projects/project_hypothesis.shtml)).

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## 8. Checking Your Hypothesis

If you cannot test your stream quality, you can look up information from stream surveys by government and citizen organizations. If you are in Maryland, check your hypothesis by doing one of the following:

**Go to Step 9A:** Observe **Watershed Health** on your Field Scope map. This layer incorporates the results of various stream and watershed surveys done by the Maryland Department of Natural Resources.

**OR Go to Step 9B:** Check the **health of your stream**, by following step 9B. You will need to go to a different website, hosted by the Maryland Department of Natural Resources.

9A. Add the “**Watershed Health**” layer to your map. Click on “**Select Map Layers**”

- Uncheck the “**Impervious Surfaces**” layer box.
- Add the “**Watershed Health**” layer box.
- Click “**Next**” and *adjust the transparency*.

? What is the health of your watershed? Is it what you expected? If not, do you have ideas on why it is different?

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9B. **Looking Up Stream Data:** The Maryland Stream Health website provides a map with data from thousands of stream surveys. Likely, your local stream or river can be found on this site.

- Go to the Maryland Stream Health website:  
<http://dnr.maryland.gov/streams/Pages/streamhealth/default.aspx>
- Go to: <https://goo.gl/6KHF3W> or [here](#) for the Interactive Maryland Stream Health Map
- Enter the name of your stream or your location in the search box.
- Streams that have been assessed are shown in colors or as triangles. Click on these symbols to learn more.

? What is the health of your stream? Is it what you expected? If not, do you have ideas on why it is different?

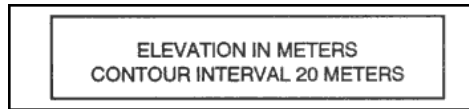
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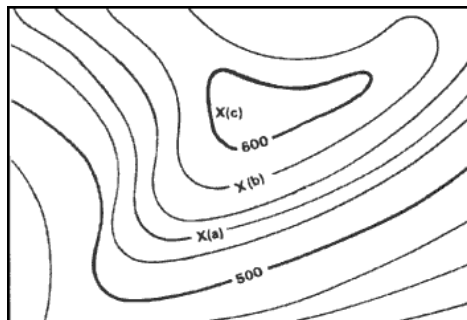
## Interpreting Topographic Maps

Basic Concepts:

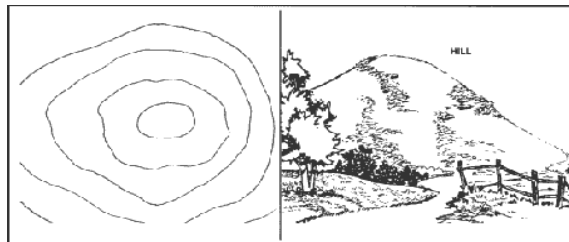
**Contour interval** is the difference in elevation between two adjacent contours. Typically, the contour interval is given in the map legend, as seen below. Think of it as the vertical distance you would need to climb or descend from one contour to the next.



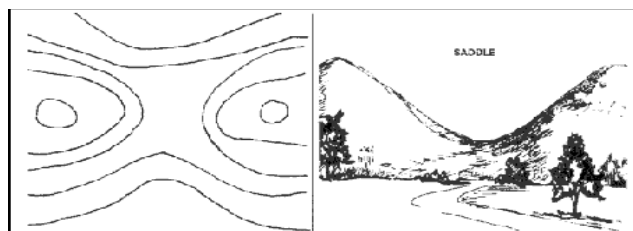
**Contour lines** represent a ground elevation or vertical distance above a reference point such as sea level. All points along a contour line are the same elevation.



**Hill.** A hill is an area of high ground. From a hilltop, the ground slopes down in all directions. A hill is shown on a map by contour lines forming concentric circles. The inside of the smallest closed circle is the hilltop.

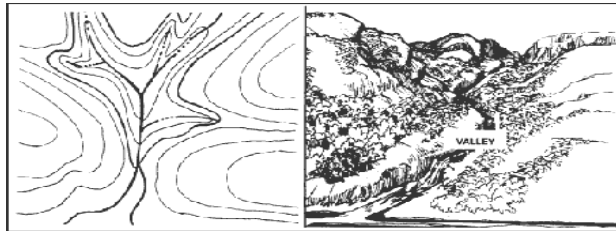


**Saddle.** A saddle is a dip or low point between two areas of higher ground. A saddle is not necessarily the lower ground between two hilltops; it may be simply a dip or break along a level ridge crest. If you are in a saddle, there is high ground in two opposite directions and lower ground in the other two directions. A saddle is normally represented as an hourglass, such as the representation on the left.

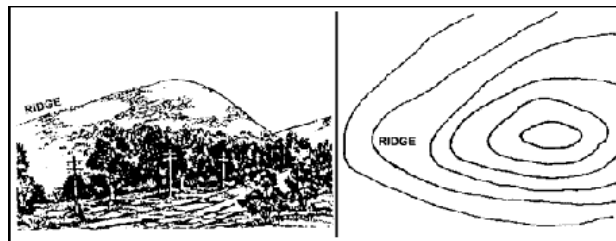




**Valley.** A valley is a stretched-out groove in the land, usually formed by streams or rivers. A valley begins with high ground on three sides, and usually has a course of running water through it. Imagine standing in the valley pictured below; the ground would be higher in three directions and lower in the fourth direction. Depending upon where you are standing and how big the valley is, it might not be obvious that the ground is higher in the third direction, but the stream, river, or runoff will flow from higher to lower ground. The contour lines representing a valley are either V-shaped or U-shaped. The shape enables you to determine the direction water is flowing. Think of the U or V shape as an arrow that points downstream and toward lower ground. (The wider end is on higher ground.) In the topographic map below, you can also see tributaries flowing into a larger stream.



**Ridge.** A ridge is a sloping line of high ground. If you are standing on the centerline of a ridge, you will normally have low ground in three directions and high ground in one direction with varying degrees of slope. (See illustration below.) If you were to cross a ridge at a right angle, you would climb steeply to its crest and then descend steeply to its base. Contour lines forming a ridge tend to be U-shaped or V-shaped. Again, the closed end ("arrow tip") of the contour line points downward away from high ground.



### Delineating a Watershed

The following method is used to outline a watershed on a topographic map, also known as *delineating a watershed*. It involves locating and connecting the high points around a waterbody. The resulting outline represents the *watershed divide*, as it is the high area separating watersheds. The enclosed area is the watershed (Figure E-5). This method can be used to delineate your local watershed.

1. Draw a circle at the water outlet of a body of water or the downstream point of a stream going into a larger body of water (such as a larger stream or lake). In Figure E-4 the circle is drawn on the outlet of a wetland (the hatched area).
2. Put small "X's" at the high points along both sides of the watercourse using the information you learned in this worksheet. Work your way upstream towards the headwaters (beginning of the stream) of the watershed.
3. Starting at the circle that was made in step one, draw a line connecting the "X's" (Figure E-5).
  - The line should cross the contours at right angles (be perpendicular to each contour line).
  - The line connects back to the starting point.
4. This designated area is your watershed.

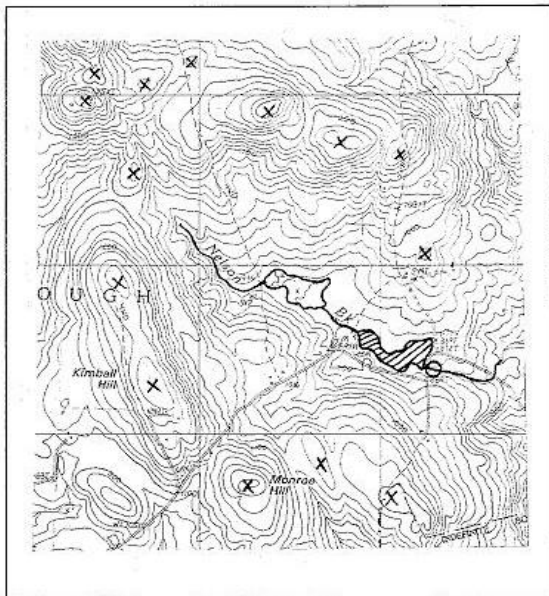


Figure E-4: Delineating a Watershed Boundary - Step 1

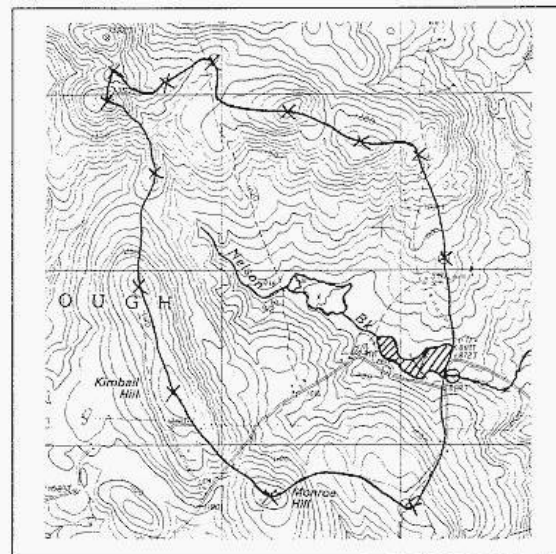


Figure E-5: Delineating a Watershed Boundary - Step 2

The delineation (Figure E-5) appears as a solid line around the watercourse. Rain falling anywhere in this area will either evaporate, infiltrate into the ground, or runoff to the stream and to its downstream point. Different land uses in this area affect the amount of runoff that reaches the stream, the speed at which it reaches the stream, and the amount of pollution it carries.

**Explain why this is true. Give two examples.**

This lesson is adapted from Appendix E of the *Method for the Comparative Evaluation of Nontidal Wetlands in New Hampshire*, 1991. Alan Ammann, PhD and Amanda Lindley Stone. This document and method is commonly called "The New Hampshire Method." For more information on how to read a topographic map, see *How to Read a Topographic Map and Delineate a Watershed*, Natural Resources Conservation Service, United States Department of Agriculture.  
[http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs144p2\\_014819.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs144p2_014819.pdf)



### Background

After reading about common water pollutants below, you will use maps, water chemistry kits, and critical thinking to answer these questions:

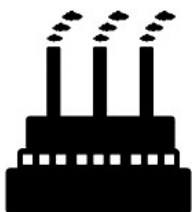
What types of nutrients and other pollutants can be measured in a watershed? Where do they come from? What harm do they cause to the tributaries of the Chesapeake Bay? What kind of contaminants affect your local stream?



**Nitrogen (N):** Nitrogen is an essential nutrient for plants and animals, but an excess of nitrogen in our waterways harms aquatic ecosystems. Nitrogen (in the forms of **nitrites**, or  $\text{NO}_2$ , and **nitrates**,  $\text{NO}_3$ ) enters water from runoff carrying farm animal manure, field fertilizers, and human wastes, as well as from vehicle exhaust in the air. Excess nitrites and nitrates in water greatly increase the growth of algae. Masses of algae block sunlight from underwater plants, and when the algae masses die, their decomposition uses oxygen. Both these factors are part of a process known as *eutrophication*, which depletes oxygen in the water. Zones in water bodies with very low levels of oxygen are called *hypoxic*, or dead zones, because fish, oysters, and most other aquatic organisms cannot survive in these areas (USF, 2000).



**Phosphorus (P):** Phosphorus, released from soils and weathered rocks, is another naturally occurring essential nutrient for plants and animals. Elevated levels of phosphorus in water bodies are caused by human activities and lead to increased algae growth and eutrophication. The largest source of phosphorus pollution is agricultural runoff from mineral fertilizers and animal waste. Other sources include industrial wastes, home fertilizers, and lawn clippings. (Watersafe, 2015)



**Carbon Dioxide ( $\text{CO}_2$ ):** Carbon dioxide is absorbed by surface waters. As the burning of fossil fuels has boosted carbon dioxide in our atmosphere, the levels of carbon dioxide in our oceans and estuaries, such as the Chesapeake Bay, also have increased. Part of the carbon dioxide reacts with the alkaline water, forming carbonic acid. The increased acidity of the water is detrimental to aquatic species, especially to animals with calcium carbonate shells, such as oysters and coral, because it triggers buffering reactions that use the carbonate minerals needed for shell building. (NOAA, 2015)



**pH:** pH is a measure of a water's acid/base content ( $\text{H}^+$  and  $\text{OH}^-$  ions), measured on pH units on a scale of 0 to 14. The pH level of a water body is influenced by the concentration of acids in rain and the types of soils in the bedrock. Most fish require waters with a pH of 6.2 to 8.2 to reproduce and survive. Increased levels of pH from anthropogenic sources include acid mine drainage from mines, known as *acid mine drainage*, and emissions from coal-burning plants, causing what is commonly called *acid rain*.



**Bacteria:** Bacteria in our waters can lead to diseases in humans and aquatic life. Fecal coliform bacteria from pets, farm animals, and human waste enter rivers via stormwater runoff and combined storm-sewer system could be present. Another recent concern is the increase in incidences of life-threatening bacteria vibrio infections in humans and seafood, likely caused by warmer waters.



**Pesticides & Herbicides:** Pesticides are chemicals used to eliminate weeds, insects and other harmful elements in crops and home gardens. Their pervasive use, however, has produced its own harm to native plants and insects. It is not uncommon to find pesticide contamination even in our drinking water. (Watersafe, 2015)



**Salinity:** Salinity is the total of all salts dissolved in water, usually expressed as parts per thousand (ppt). In an estuary, such as the Chesapeake Bay, the flow of fresh water from streams and rivers mixes with salty ocean water, producing a range of salinity from 1 to 35 ppt. Water salt content affects the distribution of animal and plant species according to the amount of salinity they can tolerate. Brackish waters, such as the tidal portions of the Potomac River, range from 10 ppt to 1 ppt salinity. Freshwater streams should have 0 ppt salinity, but their salinity (or chloride levels) can be elevated by pollutants, such as road salt (sodium chloride) and industrial waste. The accumulation and persistence of chloride in fresh water poses a risk to the plants, animals, and humans who depend upon it.

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## Nutrients and Pollutants in Your School's Watershed

After reading about pollution sources, observe a land use map of the area within your school's watershed (or 2 square miles around your campus, if you do not know the subwatershed). What types of contaminants might be found in your school's watershed? (For Maryland areas, see this site for land-use maps: <http://planning.maryland.gov/OurWork/landuse.shtml>)

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## Observations of Collection Sites

You will collect stormwater runoff from a stormwater pond or from various spots on your campus. Observe and record information about the areas you are testing below. Include variables that might affect your results, such as vegetation or traffic in the nearby area. Include the following.

- The type of water source and its location
- The clarity and color of water
- Land cover in the area contributing to the runoff
- Presence of living organisms in the water
- Weather in the preceding 12 hours (note if it is raining while collecting)

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## The Water Chemistry Kits

The tests are best performed by at least two people, so that someone can read the directions and operate the timer, while the other performs the steps. As always during labs, it is best to read the directions before doing the experiment and to wear the necessary protective gear. Disposable gloves are recommended for these tests.

### Nitrate and Nitrite

1. Carefully open Nitrate/Nitrite Test packet, and take out test strip.
2. Immerse the reagent pads\* into the water sample for 2 seconds, and then remove. (Count 1000, 2000, or use a timer.)
3. After 1 minute, match the colors to chart below. (The colors will be stable for 1 minute.)
4. Record the results of your Total Nitrate/Nitrite in the top chart. The reagent pad for nitrate/nitrite is at the *end of the test strip*.
5. The reagent pad indicating the presence of nitrites is *nearest to the strip handle*. Record the results in the bottom chart.

#### Total Nitrate/Nitrite

Water Sample	Low Nitrite 0 ppm	0.5 ppm	2.0 ppm	5.0 ppm	10.0 ppm	20.0 ppm	High 50 ppm
A.							
B.							
C.							
D.							

The unit of measurement is parts per million (ppm), which is equivalent to mg/liter.

#### Nitrites

Water Sample	Low Nitrite 0 ppm	0.15 ppm	0.3 ppm	2.0 ppm	5.0 ppm	10.0 ppm	20.0 ppm	High Nitrite 50 ppm
A.								
B.								
C.								
D.								

\*Reagent: a substance or compound used to test for the presence of another substance by causing a chemical reaction with it.

## Bacteria

- 1) Take out the Bacteria Test vial and set upright on a flat surface.
- 2) Carefully twist off cap and fill vial to the 5 ml line with the water sample. DO NOT OVERFILL, and DO NOT SPILL the bacterial growth powder in the vial. Using a dropper helps.
- 3) Replace the cap and twist on tightly. Shake the vial vigorously for 20 seconds.
- 4) Place the capped vial upright in an area 70-90 °F where it cannot be disturbed for 48 hrs.
- 5) Mark your sample if there are multiple test vials.
- 6) After 48 hours, without opening the vial, observe the color of the liquid:
  - a. Purple Color: Negative Result
  - b. Yellow Color: Positive Result - meaning a high likelihood of potentially harmful bacteria.
- 7) Record the results in the table below.

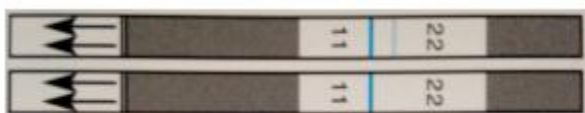
Water Sample	Positive	Negative
A.		
B.		
C.		
D.		

## Pesticides and Lead

The Lead/Pesticide Test detects dissolved lead at levels below the EPA Action level (15 ppb) and two common herbicides used in the United States at or below the EPA Maximum Contaminant Level –atrazine (3 ppb) and simazine (4 ppb). A positive result does not distinguish which substance is present; rather, it indicates that the sample contains lead and/or pesticides at a toxic level.

- 1) Open Lead/Pesticide packet and take out all contents. The packet contains a test vial, a dropper pipette, and two test strips.
- 2) Using the dropper, put exactly TWO full droppers of water sample into test vial. To pick up sample, tightly squeeze the bulb at the end of the dropper and place the open end into water sample. Release the bulb to pick up sample. Squeeze to expel sample in the vial.
- 3) Swirl gently for several seconds. Place on a flat surface.
- 4) Place both test strips into the test vial, with arrows pointing DOWN.
- 5) Wait 10 minutes. Do not disturb strips or vial during this time. Blue lines will appear on the strips.
- 6) Take the strips out of the vial and lay them on a flat surface with the arrows pointing to the LEFT. Read Results.

Negative: LEFT line (next to number 1) is darker than the RIGHT line (next to number 2).



Positive: RIGHT line (next to number 2) is darker than LEFT line (next to number 1), or lines are equally dark (Both LEFT and RIGHT lines are equally dark)





Note: If no lines appear, or both lines are very light, the test did not run properly, and the results are not valid. If a test strip shows a positive result, your water sample may contain lead or pesticides at a toxic level.

- 7) Record the results for each sample as negative or positive for pesticides detected.

Water Sample	Positive	Negative
A.		
B.		
C.		
D.		

### pH/Hardness/Chlorine

- Carefully open pH / Hardness / Chlorine Test packet and take out test strip.
- Immerse strip into water sample and remove immediately. Hold the strip level for 15 seconds.
- Match pH, Total Hardness and Total Chlorine strips (in that order) to the color charts below and record your results.

The pH reagent pad is at the end of the test strip. Match it to the color chart below.

Water Sample	6.0	6.5	7.5	8.5	10
A.					
B.					
C.					
D.					

The hardness reagent pad is in the middle of the strip. Match it to the color chart below. Record results in ppm.

Water Sample	0	50	120	250	425
A.					
B.					
C.					
D.					

The chlorine reagent pad is nearest the strip handle. Match it to the color chart below. Record results in ppm.

Water Sample	0	50	120	250
A.				
B.				
C.				
D.				

### Water Test Desired Values

The Environmental Protection Agency (EPA) has established the following maximum contaminant levels for drinking water under the National Primary Drinking Water Regulations.

More information can be found at the EPA's Table of Regulated Drinking Water Contaminants.

<https://www.epa.gov/ground-water-and-drinking-water/table-regulated-drinking-water-contaminants>

Bacteria	None
Lead	Below 15 ppb
Pesticides (atrazine/simazine)	Below 3 ppb atrazine Below 4 ppb simazine
Total Nitrate/Nitrite	Below 10 ppm
Nitrite	Below 1 ppm
pH	6.5 to 8.5
Total Hardness	50 ppm or less
Total Chlorine	Below 4 ppm

How do your results compare to the above EPA standards?

How could stormwater runoff affect our drinking water sources? What other reasons would the following contaminants in stormwater be a problem?

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# Assessing Your Campus

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**Score Four: Students, Schools, Streams, and the Bay**

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Name: \_\_\_\_\_

Date: \_\_\_\_\_

**Background**

As you remember from the Water Cycle, when it rains, some of the rain *infiltrates*, or seeps into the ground. Some runs off into streams or lakes. Some evaporates. In forests, much of the rain infiltrates into the ground because the surface is *permeable*, meaning that it has small holes that water can enter and pass through. Permeable surfaces allow the rain drops to soak into the ground. If the ground itself is porous (filled with small holes), the water will continue percolating down through the soil; in the process, many pollutants will be filtered out before the water reaches a stream or ground water.

In contrast, when it rains in urban areas, the water cannot infiltrate into *impermeable* surfaces such as roofs, roads, and sidewalks. With nowhere else to go, the rain water runs rapidly off the surfaces and carries pollutants into the nearest body of water. This is called *stormwater runoff*.

It is important to keep in mind that not all surfaces have the same level of permeability. Some areas are compacted by machines or foot traffic. This reduces the amount of pores on their surfaces and in the underlying ground. In the following assignment, you will consider the factors that influence an area's permeability and predict which areas on your school campus are more permeable than others.

**Definitions**

**Permeable** or pervious describes a surface that allows water (or fluid) to pass through.

**Impermeable** or impervious describes a surface that does not allow water to pass through.

**Instructions**

You are given a map of your school with a grid. The grid on the map divides your school campus into small sections. Predict how permeable the area in each box is by writing a rating of 0, 1, or 2 in the box. A rating of 0 means that stormwater runoff cannot enter the ground. A rating of 2 means that stormwater runoff enters the ground very easily.

- 0 = impermeable
- 1 = a little permeable
- 2 = very permeable

When you have completed the grid, answer the questions on page 2.

## Questions

1. What percent of your school campus was rated as 0, impermeable?
2. What percent of your school campus was rated as 1, semi-permeable?
3. What percent of your school campus was rated as 2, permeable?
4. Which areas did you rate as 1 and why?

### Calculations:

$$\frac{\text{\# of boxes for rating}}{\text{Total \# of boxes}} \times 100 = \%$$

*Example:*

$$\frac{60 \text{ boxes for rating of 0}}{216 \text{ boxes}} \times 100 = 27.8\% \text{ impermeable}$$

5. Based on your map and what you have learned, how do you think the amount of impermeable surfaces on your school grounds affects the quality of your stream next to your school? Explain why and provide examples.

## Extra Credit

1. Using a red marker, circle areas on the map where you think the most stormwater runoff comes from during a rain storm.
2. Using a blue marker, put stars on spots where you think a Best Management Practice (BMP) could help reduce the amount of stormwater runoff on your school campus. BMPs include rain barrels, trees, and gardens.



## Objective

- To learn about the concept of permeability, infiltration, and surface water runoff on different surfaces.
- To compare results to permeability data from maps.
- To define parameters of the field test (for higher grades).

## Materials for Each Team

- 6-inch PVC pipe 3-in diameter
  - 1000 ml-measuring cup
  - Stop watch
  - Small map of school grounds
  - Clear ruler with metric marks
  - Red, green, and yellow markers and pencil
  - Directions for Permeability Field Test
  - Field Observation Sheet
  - Container of water for multiple sites (could be 2-liter soda bottle)
- 

## Background

In this field inquiry, your class will investigate different land uses or covers on your campus and determine whether they are permeable, semi-permeable, or impermeable. The different areas should include gardens, mulched areas, sport fields, sidewalks, wooded edges, walking paths, and other types of land-use areas on your campus.

- The class will start by *forming hypotheses* about which area under investigation is most permeable and which area is least permeable.
- Then teams will go to the different areas and conduct the permeability field test. The *procedure* for this test is on the next page.
- Afterwards, you will *compile the class results* on a class table or graph and a large map of the campus.
- From these results, you will *draw conclusions* about stormwater runoff on the campus and *make recommendations* about possible areas where rain gardens, conservation gardens, rain barrels, or trees could reduce the amount of stormwater.

## Field Test Procedure

Your team will do the following procedure. For consistency each team member will do an assigned task throughout the investigation (Reader, Recorder(s), Holder, Timer, Pourer). Read and *practice* these instructions before you start.

As you complete a test, **mark the test site on your map**. Label each test site according to your team's letter and the number of the test. (If you are team A, your first site will be labeled A1, your second site, A2, and so on.) **Record your observations on the Team Field Observation Sheet.**

1. Fill your cup or bottle with 650 ml of water.
2. Push the cylinder into the ground to the black line on the cylinder. (For areas where the pipe *cannot* be put in the ground, go to Step 3.) Do the following steps:
  - One person applies constant pressure to the top of the container to prevent water from leaking out around the bottom.
  - The Timer starts the stopwatch at the same time the Pourer begins to pour 650 ml of water into the cylinder.
  - *If the water infiltrates before 3 minutes*, the Timer stops the watch at that point. The Data Recorder writes the length of time in seconds on the Team Field Observation Sheet.
  - Otherwise, stop the watch at 3 minutes. If water remains in the cylinder, measure from the rim of the cylinder to the water level (in centimeters). The Data Recorder notes this on the Observation Sheet.
3. If the cylinder cannot be put into the ground, you will pour the water on the surface and *record what happens on your Observation Sheet and map*.
  - Does it pool?
  - Does it flow in a certain direction? Make a red arrow on your map that shows which direction the water flows.

---

## RESULTS: Directions for the Group Map

Each team marks their sites on the large map according to the following:

- If all the water seeped into the ground within **3 minutes**, put a **GREEN dot** on the test site.
- If **some water remained in the cylinder, but greater than 2 cm infiltrated** into the ground, put a **YELLOW dot** on the test site.
- If **less than 2 cm** (or no water) infiltrated into the ground, mark the test site with a **RED Dot, and red arrow** if you tested the direction of water flow.
- Extrapolate the results: If all the test sites in a designated area have the same color of dots, mark the entire area with that color (or stripes of that color).
- Make a map key. Define which colored dots represent *permeable, semi-permeable, or impermeable*.

## TEAM FIELD OBSERVATION SHEET

Weather: Did it rain yesterday? \_\_\_\_\_

TEST SITE NUMBER (For example, A1, A2, A3...)	TEST SITE DESCRIPTION (Examples: garden, foot path, playground, parking lot)	TIME FOR WATER TO INFILTRATE (sec.) (If the water would not infiltrate, write impermeable.)	Distance from rim to the water level (cm) (The amount that infiltrated.)	OBSERVATIONS <ul style="list-style-type: none"> <li>Note things that could have influenced your results, for instance: Was the ground wet? Did water seep out your cylinder?</li> </ul>

## EXAMPLE CLASS TABLE

### Directions:

*Time to infiltrate:* If the water did not infiltrate within 180 seconds, write **>180 sec.** If it did not infiltrate at all, write Impermeable.

*Averaging:* When the water does not infiltrate within 180 seconds, it will take creative thinking to “average” the Time-to-Infiltrate results. Your class can decide the appropriate value to use, or whether to just to consider the average amount of water that infiltrated for that site.

*Distance from rim:* If the water did not infiltrate into the ground at all, write zero.

	Test Site 1		Test Site 2		Test Site 3		Test Site 4	
	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)
Team A								
Team B								
Team C								
Team D								
Team E								
Average								
Is it Permeable or Semi-permeable Or Impermeable?								

## Permeability Field Investigation

## Student

	Test Site 5		Test Site 6		Test Site 7		Test Site 7	
	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)*	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)	Time to Infiltrate (seconds)	Distance from Rim to Water Level (cm)
Team A								
Team B								
Team C								
Team D								
Team E								
Average Time to Infiltrate								
Is it Permeable or Semi-permeable or Impermeable?								



### Objectives

In this field inquiry, you team up with fellow students to do a stormwater assessment of your campus. Such assessments are done by landscape architects, water resource professionals, and home owners as a first step in determining optimal stormwater solutions for properties. Your objectives follow.

1. Record the sources and patterns of stormwater runoff on your campus.
2. Identify areas that contribute to stormwater pollution, such as eroding hillsides, patches of bare lawn, or trash sources.
3. Identify landscape features.
4. List two or three possible locations for YOUR Stormwater Action Project.

---

### Materials for Each Team

- Map of the school (from the computer or drawn).
- Paper to sketch on
- Directions and the Map Key
- Pencils or colored pens
- Clip board or hard writing surface
- Container of water
- Camera (optional)

### Instructions: Observe Stormwater Runoff Flow Paths and Problems

Observing stormwater flow and stormwater problems is easiest – and most fun – during or after it rains. Most likely, that won't be possible for your class, so tips on determining this information follow.

- **Find and mark the following on your map, using the symbols in your map key (page 2):**
  - Stormwater downspouts on your building
  - Stormwater ditches, gutters, or gullies, where rainwater collects and flows
  - Stormwater drains, into which water flows
  - Impermeable areas, such as parking lots
  - Hills
  - Places in the lawn where the grass is flattened and may be leaning in the direction of flow.
  - Areas where dirt has collected from erosion.
  - Areas that remain wet.
  - Places that are eroding.
- **Mark the direction of the water flow for all the identified areas.**
  - If you cannot tell the slope of the surface, pour water on it to see which direction the water flows.

MAP KEY	
G	Garden (outline the shape)
T	Tree (or draw a stick tree)
Woods	Woods (or draw multiple stick trees)
SD	Storm drains
Dwn	Downspouts on the school (Draw an arrow showing the direction of flow on the ground.)
→	Stormwater flow path
IM	Impervious surfaces on the ground. Draw an arrow for the direction of flow.
PND	Areas where stormwater ponds on the grounds. (Draw the area.)
ER	Areas of erosion (including bare patches on the lawn).
Dch	Stormwater ditches
Hill	Hills or steep slopes
SAP	Possible Stormwater Action Project locations
Ut	Any marked underground utilities, if known.
Tsh	Trash source

Mark your observations on your map, using the abbreviations and symbols in the Map Key. If the area you are assessing does not show up well on the map, make a simple line drawing of the area, keeping features in proportion as much as possible. You can add items to the key that are not on it.

### Field Notes:

Put additional observations here.

**Follow-up Class Discussion:**

Answer these questions with your team, so that you are prepared to discuss them with the whole class.

1. Were there any areas that had stormwater runoff problems? If so, describe them and the location.
2. Where did most of the stormwater runoff come from?
3. What areas could be possible sites for a Stormwater Action Project to reduce stormwater runoff on the campus? Why would these areas be good sites?

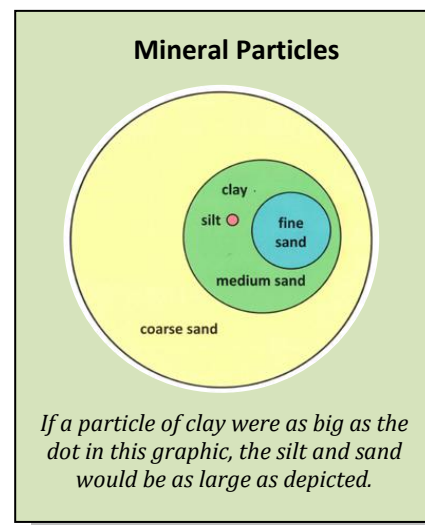
## Background

Soil is more complex than most people realize. Healthy soil consists of the following elements:

- Mineral particles — sand, silt, or clay
- Organic matter — decomposing plants, animal matter and droppings
- Small organisms — worms and insects and microorganisms, such as bacteria and fungi
- The space between mineral particles (pore space).

This investigation explores the *three types of mineral particles in soils: sand, silt, and clay*. These minerals differ in size and composition. Sand has the largest particles; silt has much smaller ones; clay particles are so small they must be seen with a powerful electron microscope.

Soils have different *textures* according to the proportions of sand, silt, or clay particles in the soil. In the following activity, you will determine the textural characteristics of sand, clay, silt. From the information you gather, you will estimate the mineral composition of a soil sample from your school grounds.



## Soil Texture Investigation

### Materials

- Samples of sand, clay, silt, and school soil
- Spray bottle of water or dropper
- 3 spoons

### Procedure

Each person in your team can do each of the following steps. One person should record the answers.

1. Put 3 teaspoons of your first soil sample, sand, into your palm.
2. Moisten the soil sample with the spray bottle or dropper. Your sample should be moist, not wet. Knead it to break up lumps. It is the proper consistency when it is moldable, like moist putty. If it is too wet, add more sand. If it is too dry, add more water.
3. Use this sample to answer the questions in **Texture Test Chart** (page 2). Write your answers in the appropriate column.
4. Put 3 teaspoons of clay in your palm. Follow steps 2-3 with the clay sample.
5. Repeat the procedure with 3 teaspoons of silt and then with your school soil sample.
6. After all the samples have been tested, answer the **Discussion Questions** (page 2).

## Texture Test Chart

Using your soil sample, answer the following questions. Answer yes or no in the column for your sample.	Sand	Clay	Silt	School Soil
a. Can you form a ball?				
b. Does it stay a ball when squeezed?				
c. Can you form a ball and then roll the ball into a snake?				
d. Can you form a ring with the snake shape?				
e. Does your sample feel gritty?				
f. Does your sample feel like flour or powder?				
g. Does your sample feel sticky?				
h. What color is the sample?				

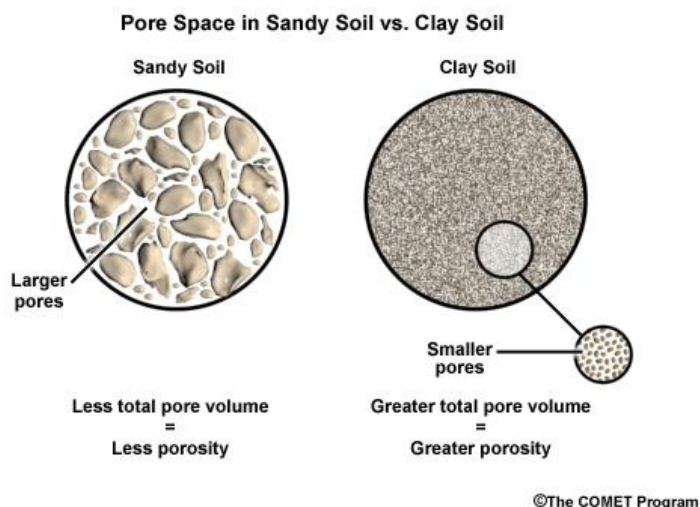
## Discussion Questions

1. From the Background paragraph and your Texture Test results, describe two characteristics of sand.
2. From the Background paragraph and your Texture Test results, describe two characteristics of moist clay.
3. How was the school soil sample similar or different than the sand and silt characteristics?
4. Using the information you gathered, how would you classify the school soil—as sand, silt, clay, silty clay, sandy clay, or loam? (*Loam* is about equal portions of sand and silt with a little bit of clay.)



### Background

As you discovered in the Soil Texture Investigation, the texture of soil reflects the amount of sand, clay, and silt in that soil. Recall that sand has relatively large particles and that clay has miniscule ones. These minerals also have spaces between their particles, called *pores*. Smaller minerals fit more closely together and so have smaller pores. The soil's composition and its *porosity* (the volume of pores in the soil) influence the ability of water to infiltrate into and *percolate* (pass down) through the soil. Interestingly, porosity also affects the soil's capacity to store, or retain, water. In this activity, you will investigate the percolation rates of the minerals sand and clay, as well as soil samples from your school grounds. You will draw conclusions – or perhaps, raise more questions – about the relationship between porosity and percolation in these samples.



### Definition

**Loam** is soil that consists of about equal parts sand and silt and a smaller portion of clay. Loamy soils from different areas consist of differing amounts of sand, silt, and clay. Loam also usually includes organic matter (decomposed plants, animals, bacteria, and fungi). The composition and porosity of loams enable them to retain nutrients and water, while also allowing the percolation of water. These features make loam excellent for gardening and reducing erosion and stormwater runoff.

Is your school soil loam?

### Materials

- Water
- 1 Timer
- 1 Measuring cup or beaker
- 1 clear 2-liter bottle top for **each** soil sample\*
- 1 clear 2-liter bottle bottom or similar container for **each** soil sample\*
- 1 piece of window screen for **each** soil sample\*
- 500 mL of each soil sample: sand, clay, loam, school soil
- Extra containers to place wet bottle tops containing wet soil samples
- The class should have containers or bags in which to place the wet soil samples. The soils can be dried and stored for future use.

\* The teacher lesson plan shows how to prepare two-liter bottles for this inquiry. If students want to prepare the inquiry materials, see these [directions](https://www.potomacriver.org/wp-content/uploads/2015/09/Soils-Percolation-Teacher.pdf): <https://www.potomacriver.org/wp-content/uploads/2015/09/Soils-Percolation-Teacher.pdf>.

**Pre-Lab:** Predict water percolation by answering the **A**-lettered questions in the **Percolation Test Chart (last page)**.

### Lab Procedure

**Before starting, read the entire procedure.** Assign each group member a job: Reader, Timer, Measurer, Pourer, Data Recorder.

1. Balance the top half of the 2-liter bottle upside down in the bottle's bottom half. Center the window screen in the top part; press the screen down inside bottle to cover the opening.
2. While holding the screen in place, pour 500 milliliters (mL) of soil into the top. Clay can be approximated and needs to be placed so that it leaves no gaps along the bottle sides.
3. Fill the measuring cup with 500 mL of water.
4. Start the timer and begin to pour the water at the same time.
5. When water first drips into the bottom of the bottle, record the time on the data chart. **(BUT don't stop the timer.)**
6. After 4 minutes, remove the top bottle half. Measure how much water is in the bottom. Record this amount on your **Percolation Test Chart**.
7. Answer all of the **B** lettered questions that are answered for that soil sample.
8. Repeat steps 1- 8 with your other soil samples, if applicable.
9. Record your team's data on a **Class Data Table**.
10. Use the class data to answer the **Post-Lab Discussion Questions**.

## Percolation Test Chart

Put your answer in the appropriate column. In the far right column, give explanations for your answers for each test that is conducted. Explanations can be written on a separate page, if more space is needed.

A. Prediction B. Observation	Sand	Clay	Loam	School Soil	Explanations
1A. Will the water run out through the bottom of the bottle?					
1B. Did the water run out of the bottom of the bottle?					
2A. How many ml of water will run out?					
2B. How many ml of water percolated through?					
3A. How many seconds will it take for the water to pass through the soil?					
3B. The time it took for the water to percolate:					
4A. What will the water look like when it comes through?					
4B. What does the water look like?					

## Class Data Table

	Sand		Clay		Loam		School Soil	
	Amount percolated after 4 min. (mL)	Time for water to percolate (sec.)	Amount percolated after 4 min. (mL)	Time for water to percolate (sec.)	Amount percolated after 4 min. (mL)	Time for water to percolate (sec.)	Amount percolated after 4 min. (mL)	Time for water to percolate (sec.)
Team 1								
Team 2								
Team 3								
Team 4								
Team 5								
Team 6								
total								
Average								
Average Rate ml/sec								

## Post-Lab Discussion Questions

1. Which soil had the most water percolate after 4 minutes?
2. Which had the least?
3. Which soil had the fastest percolation rate?
4. Which had the slowest?
5. EXTRA CREDIT CHALLENGE: Rain gardens are shaped like a basin to catch stormwater runoff. The runoff slowly percolates through the soil, allowing plants to use it and bacteria to cleanse it. From these results, how well would a rain garden function if it were mostly sand? How would it function if it was mostly clay? What if there was a layer of clay under loam? How could you test your answer to this last question?

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# Planning Your Project

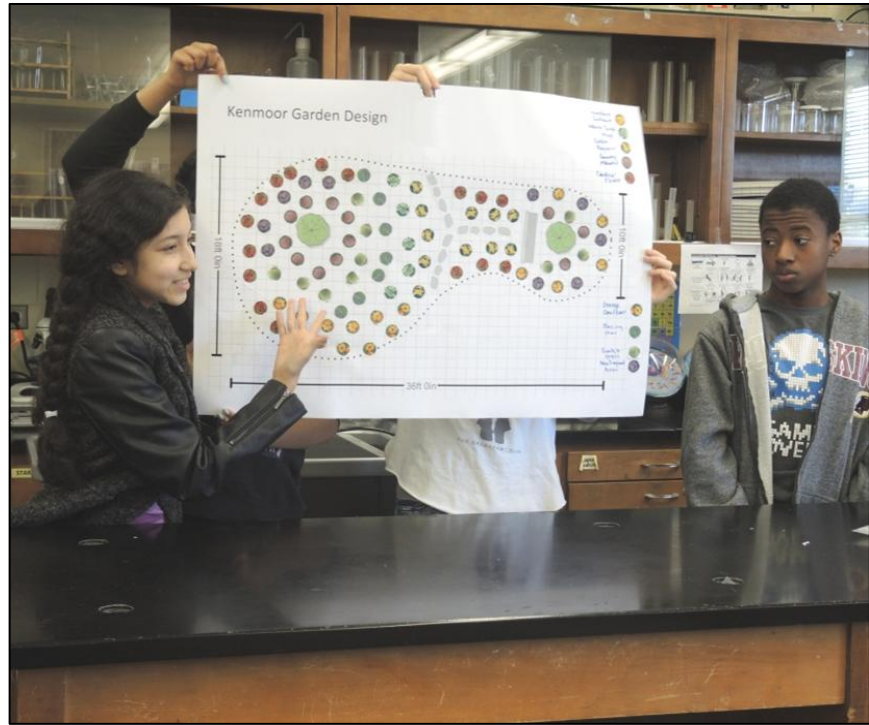
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*Lobelia cardinalis*,  
Cardinal Flower



*Asclepias incarnata*,  
Swamp Milkweed



Name: \_\_\_\_\_

Date: \_\_\_\_\_

## Goals

Project goals need to be set at the beginning of any project. Your Stormwater Action Project is no different. While the *primary goal will be to reduce stormwater runoff*, your Stormwater Action Project also can serve other goals for humans, animals, and the environment. Below are other possible goals for your Conservation Garden or Food Forest.

- Provide pollen for butterflies, birds, and insects.
- Provide habitat and food for wildlife.
- Create an outdoor classroom or sitting area.
- Provide food for humans.
- Provide a beautiful space for students and teachers to enjoy.
- Provide places for the scientific observation of plant growth, soil changes, pollination, etc.
- Reduce carbon dioxide air pollution.
- Provide education on stormwater reduction (through signage).

---

### Envision your school project. What goals do want to set for your project?

Note: these goals will be further discussed with the class, so that all students involved in the Stormwater Action Project have a voice in determining which goals are most important.

## Picking the Best Location

The location of your stormwater project is a key consideration. For instance, a Conservation Garden might reduce stormwater runoff on two different sites, but one of those locations might not be visible to students. If your goals include student usage or public educational value, the site with little visibility would be a poor choice.

Use the findings from your investigations and goal-setting session to answer the following questions. The answers can guide your classes' decision-making process. Feel free to add other characteristics to this decision-making-table.

Use your results to frame your class discussion on site selection. Determine if more information is needed before a final selection can be made. If necessary, determine which aspects are most important.

	Site A	Site B	Site C	Comments
Would a project on this site reduce stormwater runoff?				
Would this site support any wildlife-related goals?				
Is it important that the project be visible to students and the public?				
• Does the area have high visibility?				
Is it important that students can get to the site easily?				
• If so, can they?				
Can the site be watered and maintained easily?				
Is there ever standing water on the site?				
Does the site present particular challenges? If so, note them. (Challenges could include steep slope, deep clay, and invasive plants.)				
Does the amount of sunlight on the site support your project goals? (This question might require plant research.)				

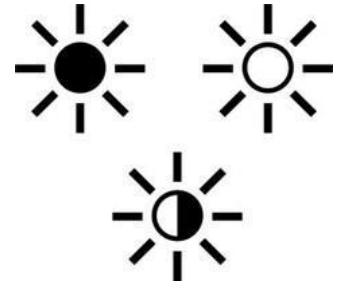


**Background**

Whether you are planting a garden, trees, or a meadow, it is important to select plants adapted to the amount of sunlight that reaches your site.

Different plants have adapted to grow under different lighting conditions. Some require *Full Sun* (at least 6 hours of light) during the growing season for optimal growth. Some do best in *Partial Shade* (3 to 6 hours of direct sunlight). Others grow well in *Shade* (less than 3 hours of direct sunlight or filtered light.)

Does your potential site(s) receive sun all day or just for part of the day? You will perform the following two exercises to determine the amount of light that will reach your site during the growing season.

**PART 1. Sun-Shade Estimate**

It helps to understand the angle of sunlight that will fall upon your site during the growing season. Although the sun rises in the east and sets in the west, the positions of the sunrises and sunsets change during the course of a year.

1. From what compass direction does the sun rise in late March? Northeast, East, or Southeast?

\_\_\_\_\_

2. From what compass direction does the sun rise in late June? Northeast, East, or Southeast?

\_\_\_\_\_

3. Where does it set in July? \_\_\_\_\_

4. Identify north on your school property. Considering the position of the sun's path during the summer, do you think your planting site will receive:

a) Morning sun? \_\_\_\_\_

b) Afternoon sun? \_\_\_\_\_

c) Morning shade? \_\_\_\_\_

d) Afternoon shade? \_\_\_\_\_

## PART 2. Sun-Shade Observation

Pick two times in the morning and at least two times in the afternoon to observe the light conditions on your site(s). For instance, make morning observations at 9:00 and 11:00 a.m. and afternoon observations at 1:00 and 4:00 p.m. Do your observations on a sunny day, and record them on the following chart. (This chart can be used for up to two locations.)

Date	Location 1		Location 2	
Time of observation	Note "sun" or "shade"	Note "shade" if this area will be shaded by trees or buildings during summer.	Note "sun" or "shade"	Note "shade" if this area will be shaded by trees or buildings during summer.

1. From your observations, how many hours of sunlight do you estimate your site will receive each day from May through August?
2. Would some areas of your garden receive less light than others, due to shade from structures?
3. Based on Exercise 1 and your observations, would you classify this site as Full Sun, Partial Shade, or Shade? Why?
4. Extra Credit Research Question: What are two native plants that would do well with this lighting?

## Directions

Different species of plants and trees have evolved to grow best under different soil, light, and moisture conditions. The best way to pick native plants that will thrive in your garden or forest is to identify ones that fit your site conditions. It is important that the plants also fulfill your project goals. The tables in this exercise will help you and your classmates select the best plants, trees, or shrubs for your Stormwater Action Project.

Use findings from previous investigations to complete the table below. Circle the conditions that fit your site. Include additional notes, such as whether the site gets morning or afternoon sunlight.

	SITE CONDITIONS	NOTES
<b>Hardiness Zone</b> (Standard that determines which plants are most likely to thrive at a location, based on winter temperature.)	<div>123456</div> <div>789101112</div>	
<b>Soil</b> What kind of soil does the site have?  What is the pH?	<div>SandLoamClay</div> <div></div>	
<b>Light</b> How much light does the site get?	<div> <input type="radio"/> Full Sun             <input type="radio"/> Part Shade             <input type="radio"/> Full Shade           </div>	
<b>Moisture</b> Is the site dry, moist, or wet, for most of the time?	<div>DryMoistWet</div>	

## Summarize:

List the conditions for which your plants or trees must be suited (for example, Zone 7a, clay, pH 7.5, part shade, wet in the spring, dry in the fall).

In the following table, you will circle the characteristics you want your garden or forest project to have. Your class decided upon some of these preferences earlier, but other characteristics relate specifically to plant selection. If you select many preferences, consider rating the choices in the notes section.

	PREFERED PROJECT CHARACTERISTICS	NOTES
<b>Maintenance</b> Can your class support plants that need high maintainance, such as frequent watering or pruning?	Low                  Medium                  High	
<b>Bloom Time</b> When would you prefer for plants to flower?	March                          April - May May – June                          July August -September	
<b>Wildlife Habitat</b> Circle the wildlife you want to attract, if any.	Butterflies                  Insects                  Birds Small Mammals	
<b>Edible Fruits &amp; Nuts</b>	Not important                  Semi-important Important	
<b>Fall Color</b> This could be colorful leaves or grasses or branches of shrubs.	Not important                  Semi-important Important	
<b>Winter Color</b> This could include grasses or evergreens.	Not important                  Semi-important Important	

## Summarize:

Discuss which ones characteristics are most important; then list the characteristics in order of importance.

## Plant Selection and Garden Design

**Now that you have selected your project goals and learned about your site's light and soil conditions, you can start designing your Stormwater Action Project.**

A design shows the shape of your conservation garden and the placement of plants, trees, and shrubs. It usually is done on a grid, so that you can plan the garden dimensions and pick the right number of plants. As you draw the plants on the design, you will leave the appropriate amount of space between them. (Different plants need different amounts of growing space.) The design process usually takes a number of draft drawings, as you try out different garden shapes and different plants. Here are some design guidelines that might help:

- Have fun and trust your creative spirit.
- Have a mix of short, medium, and tall plants. Usually, short ones go in the front and tall ones in back.
- Select plants that bloom in different months, so you will have color throughout the season.
- Large groups of flowers are more dramatic than many small groups. A mix of large groupings and smaller ones draw a viewer's attention.
- Odd numbers of plants are esthetically pleasing. Consider placing at least 5 together.
- A tree or shrubs can act as focal points or as backdrops, depending upon the site.
- The centers of perennial plants are usually 12 to 18 inches apart. Trees and shrubs are placed many feet apart. Their spacing will need to be researched.
- Clearly defined borders of a garden can bring unity to an informal shape.
- Repetition of flowers or colors throughout a garden keeps the eye moving while also tying the garden together.

## Let's Start Sketching

One way to start the design process is to use one of the garden shapes provided in this binder. You also can sketch your own shape, first using scrap paper and then the graph paper. Ask yourself:

- How big do you want the garden? Remember, you also have to weed and water it!
- Do you want an informal or formal garden?
- How will different shapes look in that area?

One of the easiest things to go outside and use a garden hose or rope to outline the garden. Experiment with different shapes and sizes.

Once you have a shape you like, decide if you want a color-themed garden, or not. For instance, you could use contrasting colors, such as yellows and purples with highlights of red, or you could have a garden of different shades of one color. Feel free to make several sketches to help you get an idea of the patterns and shapes you might like *within* your garden. Will you have a focal point, such as a bench, a tree, or bird bath? Do you want to hide a wall with tall grasses or bushes? Perhaps, it would be easier to make a sketch after you have looked at possible plants first. If so, go to the next section.

### Other Ideas to Try

The shape of the garden can enhance the grounds by tying together elements, such as lone trees, or it can be a "centerpiece" in a plain, open space.

The shape of a garden can soften a "blocky" landscape with curves.

Your garden can match the colors of other gardens on the grounds, or it can stand apart as a special, themed garden to add interest to the grounds.

Your plan can include sitting places and paths to encourage students to visit.

A garden can include signs, bird houses, or other art made by the students to establish a garden theme.

# Plant Selection and Garden Design

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## Picking Plants

If you haven't done so already, you will use the [Native Plants for Wildlife Habitat and Conservation Landscaping for the Chesapeake Bay Watershed booklet](#) and other native plant web sites to pick plants you find interesting *and that meet the site requirements*: (<http://www.nps.gov/plants/pubs/chesapeake/>).

You will start with a sketch of your garden. You will make your sketches and final design on graph paper using colored pencils. This will be a planar view from above. (Some people need to envision their garden from a frontal view first, so if it helps, do that first, sketching in plant sizes and colors you find pleasing. Then switch to the graph paper.)

- Establish a scale for the gridlines before you start drawing. For instance, each square could represent 1 square foot or 5 square feet.
- On the graph paper, you will represent each plant in a circular or bubble shape that represents each plant's size at full growth.
- Write the plant name and height in the circle, or make on a design key or table on the side of the paper with this information.

A good eraser comes in handy during this part! It can take several drafts to come up with a good design.

**Notes from the Design Presentation Go Here.**

## Planning Color for the Seasons

Plant Name	Plant Type	Interest	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
		Bloom												
		Berry												
		Leaf, Bark												
		Bloom												
		Berry												
		Leaf, Bark												
		Bloom												
		Berry												
		Leaf, Bark												
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		Berry												
		Leaf, Bark												
		Bloom												
		Berry												
		Leaf, Bark												
		Bloom												
		Berry												
		Leaf, Bark												
		Bloom												
		Berry												
		Leaf, Bark												

Thank you to Carole Barth, Prince George County Department of the Environment, for sharing this planning guide.

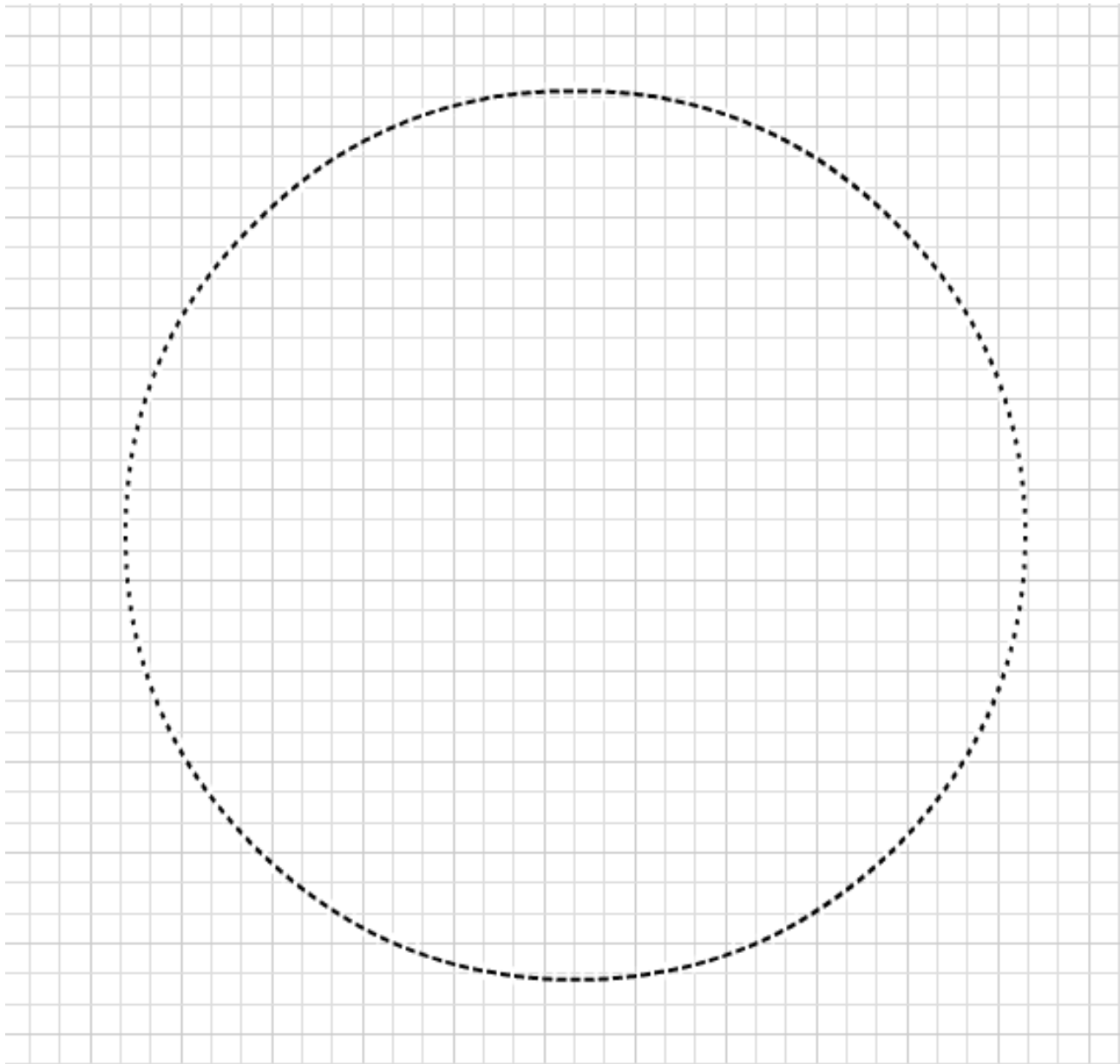


### Seasonal Plant Palette for Quiet Waters Planting

Latin Name	Interest	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
<i>Ceanothus americanus</i>	Bloom												
	Berry												
	Leaf or Bark												
<i>Chionanthus virginicus</i>	Bloom												
	Berry												
	Leaf or Bark												
<i>Clethra alnifolia</i> 'Compacta' or 'Hummingbird'	Bloom												
	Berry												
	Leaf or Bark												
<i>Comptonia peregrina</i>	Bloom												
	Berry												
	Leaf or Bark												
<i>Gaylussacia baccata</i>	Bloom												
	Berry												
	Leaf or Bark												
<i>Gaylussacia frondosa</i>	Bloom												
	Berry												
	Leaf or Bark												
<i>Ilex glabra</i> 'Nordic'	Bloom												
	Berry												
	Leaf or Bark												
<i>Itea virginica</i> 'Henry's Garnet'	Bloom												
	Berry												
	Leaf or Bark												

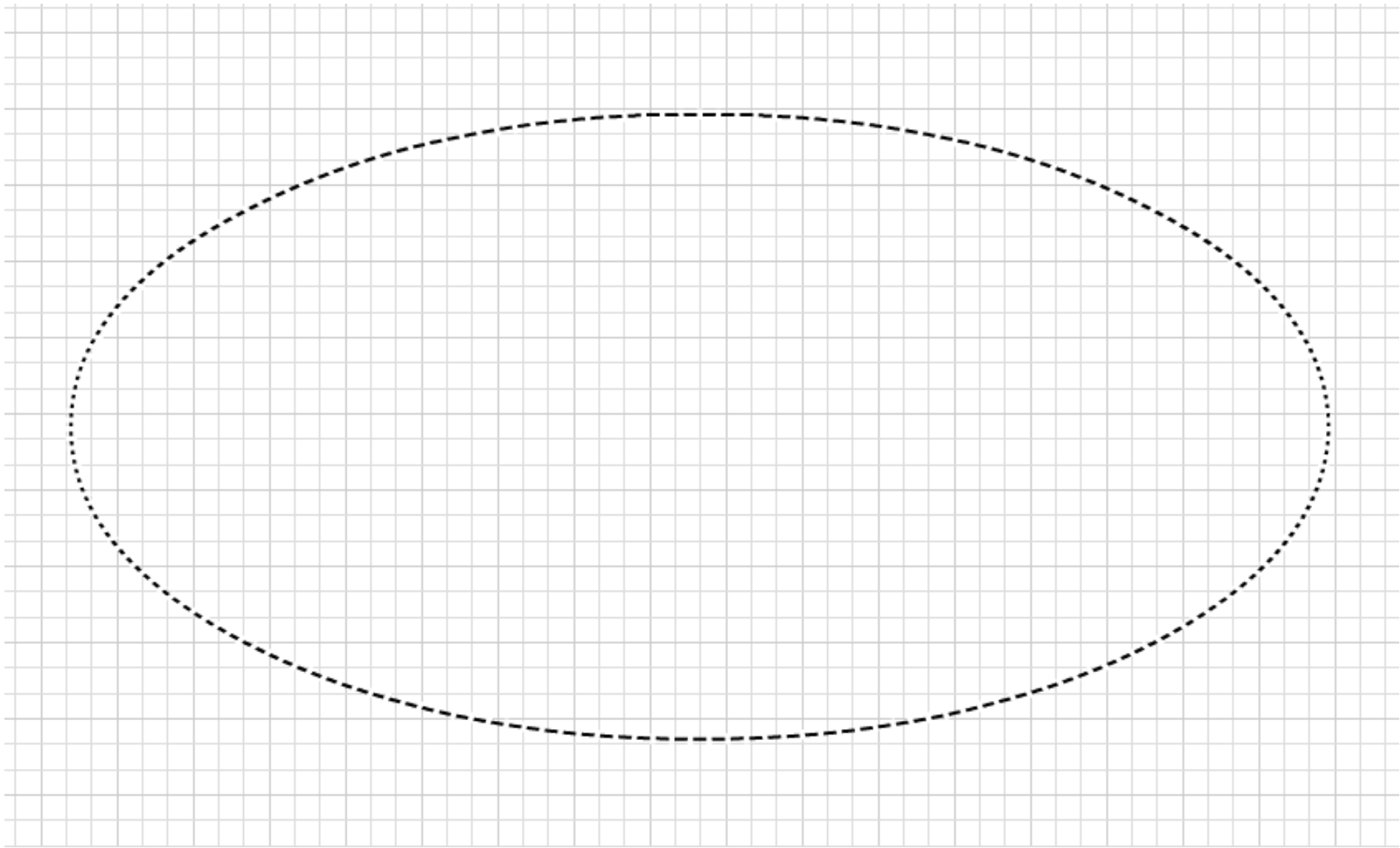
Example of completed palette, provided by Carole Barth, PGC DOE.

Garden Design



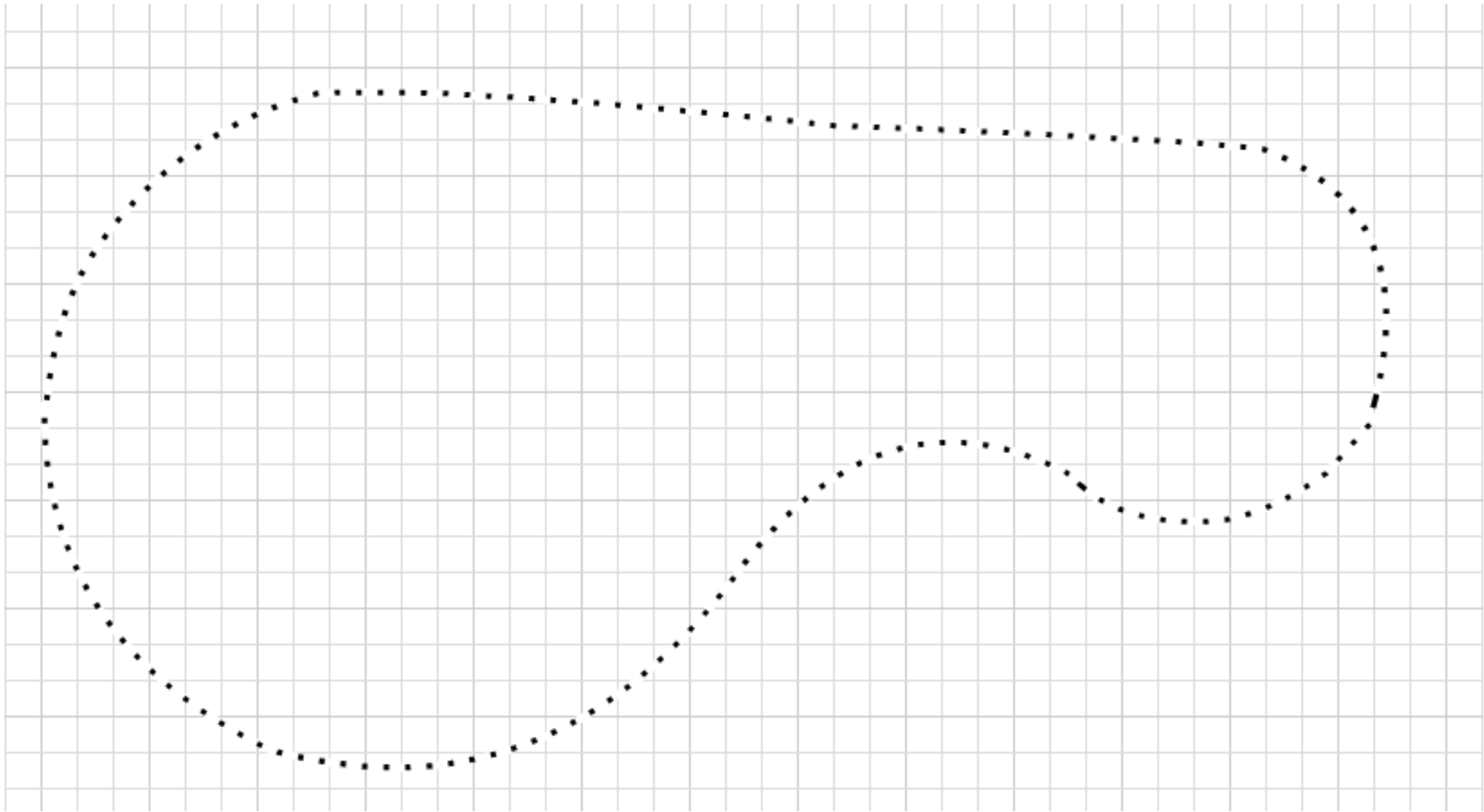
Each square = \_\_ sq. ft.

Garden Design



Each square = \_\_\_\_ sq. ft.

Garden Design



Each square = \_\_\_\_ sq. ft.

# Garden Design



Garden Design



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# Maintaining Your Project

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**Score Four: Students, Schools, Streams, and the Bay**

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## Maintenance of Your Stormwater Action Project

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All gardens and tree plantings need maintenance. When done regularly, maintenance can be fun. It is a chance to be outside, to notice the changes in your plants, to see your first flowers blossom, and to watch the butterflies and birds that come to the garden.

When projects are not maintained, the plants and trees die, weeds take over, and your site loses the capacity to reduce stormwater.

We hope you will take pride in caring for your Stormwater Action Project, so that it will provide benefits to the environment and students for years to come. The following information and the maintenance chart (p. 3) describe the maintenance needed. It is important that involved teachers and students or student clubs ensure that such maintenance will be done.

Summer is an especially critical time for your plants and trees. We hope that students will take the lead in arranging summer volunteer schedules or reach out to the community and watershed organizations for assistance.

### Watering is Essential – Spring through Fall

#### Plants

- *Hand water*, using a container or hose, around base of each plant for 1-2 minutes. Allow the water to soak into the ground, and take care not to wash away the mulch or soil.
- Here is a guideline for watering.
  - First 2 Weeks: water 3 times per week
  - Second 2 weeks: water 2 times per week
  - Next 6 weeks: water 1 time per week
  - When it rains one or more inches a week, watering may be unnecessary. Typically, watering is not needed from Nov. 30 – April 15, unless there is an extended warm dry spell in late winter or early spring.

Observe your plants regularly, especially in the first months after planting. If the soil is dry, water. If the plants are drooping, water! If the ground is soaking, don't water!

#### Trees

- Trees that have been in the ground less than 3 years require 25 gallons of water, or about 1.5 inches of rainfall, per week.
- Track rainfall totals from the weather reports or with a rain gauge. If less than 1.5 inches of rain falls in a week, it's time to water. Casey Tree Foundation will send your class a free rain gauge, if you take the [25 to Stay Alive Pledge](#) on their website.

## Mulching – Spring and Fall

Mulching is when we put a layer of shredded bark around plants and trees. Mulch acts like the fallen leaves in a forest: it reduces weed growth, keeps the moisture in soil from evaporating, regulates soil temperature, and adds organic matter to the soil.

The mulch in your garden will decompose over time (enriching your soil as it does). This means that new mulch needs to be added. *At the beginning of the school year and at the end of winter make sure that:*

- Your site has a minimum of 3 inches of mulch.
- That the surface of the mulch hasn't hardened. If this has occurred, rake away the old mulch and apply a fresh layer.

### *Mulch Dos and Don'ts*

- Mulch should be placed in a donut shape around trees *at least 3 inches away from tree trunks or shrubs*.
- Use natural mulch with no dye.
- Shredded hardwood mulch is preferred, but composted wood chips, or grass clippings can be used.
- Adding compost under the mulch will benefit your soil and plants.

Mulch slows down weeds, but it doesn't stop all of them.

Get the best of weeds, by pulling them regularly, and making sure you get their roots.

## Weeding – Spring, Summer, and Fall

Smaller weeds are easier to pull than big ones, so don't let them grow! Many weeds and invasive plants reproduce from their roots (rhizomes), as well as seeds. Therefore, it is important to dig out the roots (with a hoe, hand trowel, or other tool) and to remove weeds before they produce seeds. At the minimum, weed every 2 to 3 weeks.

## Other Fall or Spring Maintenance

*Spreading Plants:* The magic of gardens is that perennials will spread. Every 3 to 5 years, fast growing flowers, such as Obedient Plant, may need to be divided, or reduced in size by removing some of the plants with their roots. Signs of overcrowding include reduced flowering and weak, spindly stems. Extra plants represent opportunities for sharing, garden expansion, or a new garden!

*Fertilizer:* Because your site has been planted with appropriate native plants and is mulched regularly, fertilizer is not needed.

*Dead stems and seed heads:* Leaving stems and seeds in gardens throughout the winter provides food and shelter for birds and wildlife. In the late winter or early spring, old stems can be cut to about 3- 4 inches and dried grasses to about 6 inches. Old leaf litter and stems can replenish your compost pile.

*Tree and Shrub Pruning:* Pruning can be done to shape shrubs or a trees. It is unlikely that pruning will be needed in the first few years. Minor pruning will not adversely affect trees and shrubs at any time of the year. Major pruning should be done in late winter to early spring.

A handy maintenance schedule is on the following page. Your class should make its own schedule and assign people to specific jobs. If you need more volunteers, consider advertising your project to get student or parent volunteers.

Chart for Planning Maintenance of Conservation Landscapes & Bay-Wise Gardens												
Task	Month											
	January	February	March	April	May	June	July	August	September	October	November	December
Monitoring <sup>1</sup>												
Apply mulch <sup>2</sup>												
Cut back perennials and grasses <sup>3</sup>												
Watering <sup>4</sup>												
Weeding as needed <sup>5</sup>												
Replace, thin, and add plants as needed <sup>6</sup>												
Snow management <sup>7</sup>												

(Adapted from the District of the Department of the Environment Rain Garden and BayScape Maintenance Schedule)

1. Check for weeds and depth of mulch. Remove trash or other debris from garden.
2. Apply shredded cedar or hardwood mulch in April and November to maintain a depth of 3 inches.
3. Cut back perennials (not shrubs or trees) to about 4 inches.
4. Water to an equivalent of 1" per week until established. Once established (about a year), water from May to October when there has been no rain for 10 days or more.
5. Clean up winter weeds in late February/early March and then weed every two to four weeks, as necessary, from April to November.
6. Replace dead plants and thin plants if needed from June to October. The optimum times for adding or moving plants are April through May and September through October.
7. Avoid placing snow on top or in close proximity to garden. Limit deicing salt within close proximity of garden.

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# Resources

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### FUNDING SOURCES

Listed below are just a few examples of many funding sources available. Many counties and large municipalities in the Chesapeake Bay Watershed offer rebates or other incentives to encourage homeowners, religious organizations, and businesses to adopt stormwater Best Management Practices on these properties. Look for the counties' or cities' environmental or land-use departments for this information.

- Local civic clubs
- Garden centers and local garden clubs
- [Chesapeake Bay Trust](http://www.cbtrust.org/grants) offers multiple grant opportunities throughout the year  
(<http://www.cbtrust.org/grants>)
- [The Home Depot](http://corporate.homedepot.com/grants/community-impact-grants) Foundation Community Impact Grants  
(<http://corporate.homedepot.com/grants/community-impact-grants>)
- [Lowe's](http://lowes.com/community) Charitable and Educational Foundation  
(<http://lowes.com/community>)
- MD Department of Natural Resources, [Marylanders Plant Trees](http://dnr2.maryland.gov/forests/Pages/MarylandersPlantTrees/Introduction.aspx) provides \$25-off tree coupons, vendor lists, and other information.  
(<http://dnr2.maryland.gov/forests/Pages/MarylandersPlantTrees/Introduction.aspx>)
- Prince George's County (PGC), MD – PGC Department of the Environment
  - [Rain Check Rebate Program](http://www.cbtrust.org/site/c.miJPKXPCJnH/b.9146461/k.D5B/Prince_George8217s_County_Rain_Check_Rebate.htm) for home owners, religious organization, and others.  
([http://www.cbtrust.org/site/c.miJPKXPCJnH/b.9146461/k.D5B/Prince\\_George8217s\\_County\\_Rain\\_Check\\_Rebate.htm](http://www.cbtrust.org/site/c.miJPKXPCJnH/b.9146461/k.D5B/Prince_George8217s_County_Rain_Check_Rebate.htm))
  - [Arbor Day Every Day](http://www.princegeorgescountymd.gov/515/Arbor-Day-Every-Day) provides free trees for schools to plant and maintain.  
(<http://www.princegeorgescountymd.gov/515/Arbor-Day-Every-Day>)

### Stormwater Solutions – Conservation Landscaping, Rain Gardens, Trees...

#### CONSERVATION LANDSCAPING OR BAY-WISE GARDENING

- University of Maryland Extension:
  - [Bay-Wise Gardening](http://extension.umd.edu/anne-arundel-county/master-gardeners/bay-wise-gardening) provides publications and ample information on Bay-Wise Gardening. (<http://extension.umd.edu/anne-arundel-county/master-gardeners/bay-wise-gardening>)
  - [List of Master Gardeners](https://www.extension.umd.edu/baywise/program-certification) who can provide advice or assistance for your project  
(<https://www.extension.umd.edu/baywise/program-certification>)
- Montgomery County Department of Environmental Protection, [Conservation Landscaping](http://www.montgomerycountymd.gov/DEP/water/conservation-landscaping.html) includes simple explanation and resource links.  
(<http://www.montgomerycountymd.gov/DEP/water/conservation-landscaping.html>)
- [City of Rockville](http://www.rockvillemd.gov/index.aspx?NID=831), MD provides a comprehensive list of resources for rain gardens and conservation gardens.  
(<http://www.rockvillemd.gov/index.aspx?NID=831>)

#### RAIN GARDEN GUIDES

- Prince George's County, MD [Guidelines for Rain Garden](http://www.princegeorgescountymd.gov/DocumentCenter/View/180)  
(<http://www.princegeorgescountymd.gov/DocumentCenter/View/180>)
- [Rain Garden Design and Construction A Northern Virginia Homeowner's Guide](http://www.fairfaxcounty.gov/nvswcd/raingardenbk.pdf)  
(<http://www.fairfaxcounty.gov/nvswcd/raingardenbk.pdf>)

- [Rain Garden Manual for Schools A How-To Manual For Fayette County Public Schools](http://www.sustainability.fcps.net/media/641050/rain%20garden%20manual%20for%20schools.pdf)  
(http://www.sustainability.fcps.net/media/641050/rain%20garden%20manual%20for%20schools.pdf)
- [Rainscaping with Rain Gardens...Working with Nature to Transform Stormwater Runoff into Garden Oases](http://www.chesapeakeecologycenter.org/wp-content/uploads/2016/05/RainScaping-with-Rain-Gardens.pdf)  
(http://www.chesapeakeecologycenter.org/wp-content/uploads/2016/05/RainScaping-with-Rain-Gardens.pdf)
- Low Impact Development Center [Rain Garden Templates](http://www.lowimpactdevelopment.org/raingarden_design/templates.htm) provides free templates and is a good community resource.  
(http://www.lowimpactdevelopment.org/raingarden\_design/templates.htm)

### **SCHOOL YARD HABITAT**

- U.S. Fish & Wildlife Service
  - [School Yard Habitat](http://www.fws.gov/ChesapeakeBay/schoolyd.html)  
(http://www.fws.gov/ChesapeakeBay/schoolyd.html)
  - [Schoolyard Habitat Guide](http://www.fws.gov/cno/pdf/HabitatGuideColor.pdf)  
(http://www.fws.gov/cno/pdf/HabitatGuideColor.pdf)
  - Although not geared towards rain gardens and storm-water solutions, this site includes a downloadable 132-page guide for creating habitat areas, which include **good tips on the planning, maintenance, and community engagement.**
- National Wildlife Federation [Schoolyard-Habitats How-to-Guide](http://www.nwf.org/Garden-For-Wildlife/Create/Schoolyards/Resources.aspx). This site includes a downloadable guide for creating habitat areas. The assessment and planning portions may provide you with ideas.  
(http://www.nwf.org/Garden-For-Wildlife/Create/Schoolyards/Resources.aspx)

## **GARDENS – PLANT RESEARCH AND PURCHASING**

### **NATIVE PLANT RESEARCH AND SELECTION**

- U.S. Fish & Wildlife Service
  - [Native Plants for Wildlife Habitat and Conservation Landscaping](https://www.nps.gov/plants/pubs/chesapeake) Chesapeake Bay Watershed Guide. (https://www.nps.gov/plants/pubs/chesapeake)  
[PDF](https://www.nps.gov/plants/pubs/chesapeake/pdf/chesapeakenatives.pdf) Version.  
(https://www.nps.gov/plants/pubs/chesapeake/pdf/chesapeakenatives.pdf)
  - Chesapeake Bay [Native Plant Center](http://www.nativeplantcenter.net/) (http://www.nativeplantcenter.net/)
- [Lady Bird Johnson Wildflower Center](http://www.wildflower.org/plants/) (http://www.wildflower.org/plants/)
- [Missouri Botanical Garden Plant Finder](http://www.missouribotanicalgarden.org/plantfinder/plantfindersearch.aspx)  
(http://www.missouribotanicalgarden.org/plantfinder/plantfindersearch.aspx)
- [USDA Plants Database](http://plants.usda.gov/) (http://plants.usda.gov/)

### **NATIVE PLANT NURSERIES AND SALES**

- Maryland Native Plant Society
  - [Native Plant Sales](http://mdflora.org/plantsales.html) (http://mdflora.org/plantsales.html)
  - [Native Plant Nurseries](http://mdflora.org/publications/nurseries.html) (http://mdflora.org/publications/nurseries.html)

- [Chesapeake Natives](http://chesapeakenatives.org/), Upper Marlboro, MD (<http://chesapeakenatives.org/>)
- [Environmental Concern](http://www.wetland.org/), St Michaels, MD (<http://www.wetland.org/>)

## MAPS

- [Maryland Land Use Maps](http://mdpgis.mdp.state.md.us/landuse/imap/index.html) (<http://mdpgis.mdp.state.md.us/landuse/imap/index.html>)
- [U.S. Topographic Maps](http://nationalmap.gov/ustopo) (<http://nationalmap.gov/ustopo>)
- Maryland Department of Natural Resources [Stream Health Map](http://dnr2.maryland.gov/streams/Pages/streamhealth/default.aspx) (<http://dnr2.maryland.gov/streams/Pages/streamhealth/default.aspx>)
- National Geographic FieldScope:
  - [Chesapeake Bay Watershed Project](http://chesapeake.fieldscope.org/) (<http://chesapeake.fieldscope.org/>)
  - [Maryland FieldScope](http://maryland.fieldscope.org/) (<http://maryland.fieldscope.org/>)

## SOILS

- **Soil Health** USDA Natural Resources Conservation Service (NRCS): Soil Health, Soil Biology (with incredible photos of microscopic bacteria, fungi, and other soil microorganisms, that can be used with permission), and other resources, including Educator Lessons & Experiments.
  - [Gallery of Soil Microorganisms](http://www.nrcs.usda.gov/wps/portal/nrcs/photogallery/soils/health/biology/gallery/?cid=1788&position=Promo) (<http://www.nrcs.usda.gov/wps/portal/nrcs/photogallery/soils/health/biology/gallery/?cid=1788&position=Promo>)
  - [NRCS Soil Education Lesson Plans by Grade Levels](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/7thru12/?cid=nrcs142p2_054303) ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/7thru12/?cid=nrcs142p2\\_054303](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/edu/7thru12/?cid=nrcs142p2_054303))
  - [On-Line Soil Biology Primer](http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/) (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/biology/>)
- **Soil Testing in Maryland:** University of Maryland Extension
  - [Reasons for soil testing](http://extension.umd.edu/hgic/soils/soil-testing) and good video showing method for soil collection. (<http://extension.umd.edu/hgic/soils/soil-testing>)
  - [List of Soil Testing Laboratories](http://extension.umd.edu/sites/default/files/_docs/programs/hgic/HGIC_Pubs/HG110_HG110a_Selecting%20and%20Using%20a%20Soil%20Test%20Lab.9_2015.pdf) with instructions ([http://extension.umd.edu/sites/default/files/\\_docs/programs/hgic/HGIC\\_Pubs/HG110\\_HG110a\\_Selecting%20and%20Using%20a%20Soil%20Test%20Lab.9\\_2015.pdf](http://extension.umd.edu/sites/default/files/_docs/programs/hgic/HGIC_Pubs/HG110_HG110a_Selecting%20and%20Using%20a%20Soil%20Test%20Lab.9_2015.pdf))
  - For soil chemistry readings for students, see the FAQs and fact sheets about fertilizers and lead in soil.
- **Soil Testing in West Virginia:** West Virginia Extension Service, West Virginia University: [soil sampling instructions](http://anr.ext.wvu.edu/soil/taking_a_good_soil_sample), video, and laboratory ([http://anr.ext.wvu.edu/soil/taking\\_a\\_good\\_soil\\_sample](http://anr.ext.wvu.edu/soil/taking_a_good_soil_sample))
  - [West Virginia University Soil Testing](http://soiltesting.wvu.edu/) free soil sampling for WV residents (<http://soiltesting.wvu.edu/>)
- **Soil Testing in Virginia:** [Virginia Tech Soil Testing Laboratory](http://www.soiltest.vt.edu/). Also see links to local Cooperative Extension Office on this site. (<http://www.soiltest.vt.edu/>)