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.

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.

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Table of Contents

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 Sections:

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

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

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.

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.

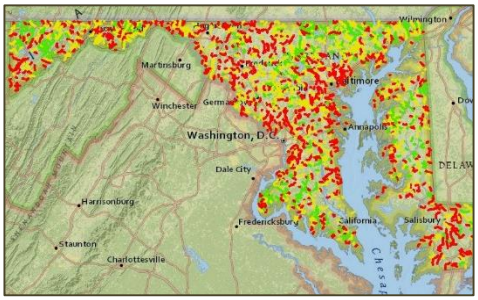
Resources: Perhaps, you might want to undertake another stormwater-reduction project. You can explore this section to learn about other options, such as rain gardens.

Exploring Your Watershed

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

FieldScope Map Inquiry:
Streams and Land Use Near Your Campus

FieldScope is an online mapping program where students can analyze, interpret, and share environmental data about their schools' watershed or an adopted stream. You will be using the Maryland FieldScope to investigate the following features of your watershed:



- Rivers and Streams
- Land Cover
- Impervious Surfaces
- Impermeability
- Stream Health

Directions

Let's start by learning how to use some of the features of FieldScope.

1. Go to *http://maryland.fieldscope.org/*
2. Click on "**Map Data.**"
3. Click on "**Create Your Own Map.**"
4. Select a Base Map.

> *A base map is the bottom layer of your map. Other map layers featuring data about the area under investigation will be layered over the base map. FieldScope offers choices of base maps with different views, place names, color schemes, etc.*

   a. The *Topographic*, *National Geographic*, or *Street Map* options are good choices for this exercise.
   b. Select a base map and click "**Next.**"

5. Select Observation Data.

> *"Select Observation Data" is where you can select the sources of data to include on your map. You are able to view stream data from the U.S. Geological Survey, Maryland Biological Stream Survey, and data from schools and watershed organizations.*

   a. We will not be looking at specific stream data at this time, so *deselect* the "**Participant Water Quality Data**" box.
   b. Click "**Next.**"

6. Set Data Display.

> *"Select Data Display" to modify how observation data is displayed on your map.*

   a. Do not make any changes.
   b. Click "**Next.**"

7. Select Map Layers.

> *"Select Map Layers is where you select which map layers you want to view on your map. The layers provide additional information.* ***Only 2 layers can be selected at a time****. You may go back to the menu to switch the map layers any time.*

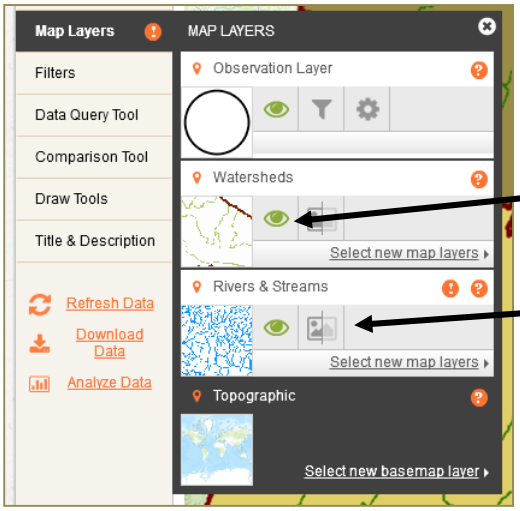
   a. Check the "**Watersheds**" box and the "**Rivers and Streams**" box to add the layers to your map.
   b. Click "**Next.**"

8. A pop-up will appear, click on "**No, Thanks. I want to explore on my own.**"

9. View Map.

   a. You will see your map with the selected layers shown.
   b. Before we look at the layers more specifically, let's go over some tools you have.

10. Transparency and Layer Visibility.



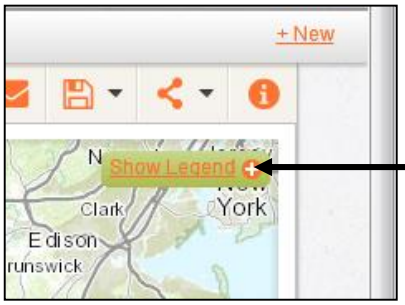
To view the selected layers more clearly, you can change the **transparency** and the **layer visibility** by clicking on the *Map Layers* tab on the left side.

Layer Visibility (the eye symbol) shows or hides the layer.

Transparency controls whether or not you can see through the layer. Zero % transparency means you cannot see through it; 100% transparency means you can completely see through it.

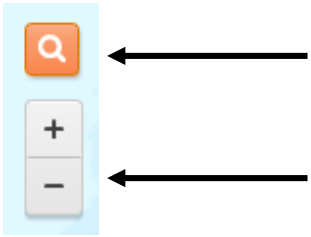
Adjust these features on the Watersheds and Rivers & Streams layers until you can see the outline on the watersheds, as well as the streams.

11. Legend.



In the top right corner of your map, click on **Show Legend** to view the legend.

12. Search and Zoom In (+) and Zoom Out (-).



At the bottom right corner, you will see a magnifying glass. You will use this to search for specific locations.

The Zoom In (+) and Zoom Out (-) buttons allow you to see a generalized map or specific details.

13. Now you ready to explore your watershed.

Watersheds and Rivers and Streams

You will use the Watersheds and Rivers and Streams layers to learn what watershed your school is in and what streams are closest to your school.

1. Adjust the **Transparency** settings to the **Watersheds layer** so you can see the map underneath.

2. Click the **Magnifying Glass** in the lower right corner and search for your school by entering the address. The location will appear as a red dot.

3. Zoom in (using the + button underneath the magnifying glass) until you can see your school's location.

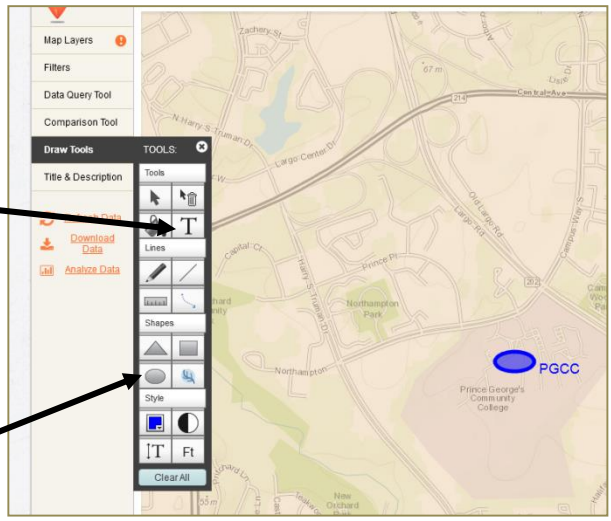
4. In the following steps you will create a marker and label for your school. The marker and label will stay in position on your map when you search for other locations or zoom out.

a. On the left hand side, click on Draw Tools. You can tell what a tool does by hovering over it.

b. Click on the "Add Label Tool."

c. Click where your school is on the map to create a label. Press enter to place the label. (If you want to move the label, use the arrow, or "select tool.")

d. Click on one of the shapes to create your marker.



e. Click where your school is on the map to create the marker. The select tool can be used to adjust the marker, and the erase tool (garbage can) can be used for corrections.

f. When you have created your label, exit out of the Draw Tools by clicking the X.

5. To find what watershed you are in, click on your school's location. A popup should appear.

   a. What watershed are you in?

6. Make sure you are zoomed in enough to see what streams are in your watershed. Click on a stream to see the name.

   a. What streams are closest to your school?

Land Cover

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.

7. Click "**Select Map Layers**" tab at the top of your screen.

8. Uncheck the "**Watersheds**" box and the "**Rivers and Streams**" box to remove the layers from your map.

9. Check the "**Land Cover**" box to add the layer to your map.

10. Click "**Next.**"

11. Adjust the **Transparency** settings accordingly, if needed.*

12. What land covers do you observe within your watershed? (See the Legend.)

Impervious Surfaces Layer

Now you will observe Impervious Surfaces 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.

13. Click "**Select Map Layers.**"

14. Uncheck the "**Land Cover**" box to remove the layer from your map.

15. Check the "**Impervious Surfaces**" box to add the layer to your map, and click **"Next" or "View Map" (at the top.)***

16. Adjust the **Transparency** settings as needed.

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

18. How do you think the stream health is affected by the types of land cover and the amount of impervious surfaces in your watershed?

Stream Health Layer

Now you will observe Stream Health on your map. This layer shows the results of stream sampling done by the Maryland Department of Natural Resources.

19. Click "**Select Map Layers.**"
20. Uncheck the "**Impervious Surfaces**" box to remove the layer from your map.
21. Check the "**Stream Health**" box to add the layer to your map. Go to your map.
22. Adjust the **Transparency** settings accordingly, if needed.
23. What do you observe? *

* A snapshot of your map can be taken by clicking on the "disc" on the upper right hand corner and selecting download.

Assessing Your Campus

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

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:

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

27.8% 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.

Permeability Field Investigation Student

Name: _____ Date: _____

Objective

- To learn about the concept of permeability, infiltration, and surface water runoff on different surfaces.

Materials for Each Team

- 6-inch PVC pipe 3-in diameter (can be cut with a hacksaw). Draw a line .25 inches (.6 cm) from the bottom on this cylinder with a Sharpie. Option: coffee cans with the ends removed can be used, but the cans must be the same size, and the sharp ends should be covered with duct tape.
- 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.

Procedure

Your team will do the following procedure. For consistency each team member will carryout 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.
    - Lastly, pour 1 liter of water on the ground near your test site and observe whether it flows in one direction or pools. If it flows in one direction, draw an arrow on your map, indicating the direction of the flow. If it pools, write the word pooled on your map.
3. If the cylinder cannot be put into the ground, you will pour the water on the surface and record what happens on your table 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.

Permeability Field Investigation

Student

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** • Note things that could have influenced your results, for instance: Was the ground wet? Did water seep out your cylinder?

Permeability Field Investigation Student

EXAMPLE CLASS TABLE

Directions:

Time to infiltrate: Write the time in seconds. If the water did not infiltrate within 180 seconds, write **>180 sec**. If it did not infiltrate at all, write Impermeable. NOTE: 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 (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	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 Site5		Test Site 6		Test Site 7		Test Site 7	
	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)*	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	Distance from Rim to Water Level (cm)	Time to Infiltrate (sec.)	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?								

Name: _____ Date: _____

Background

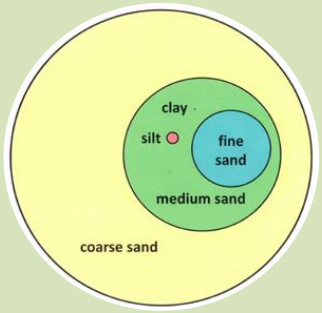
Soil is more complex than most people realize. Healthy soil consists of the following elements:

- 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.

Mineral Particles



If a particle of clay were as big as the dot in this graphic, the silt and sand would be as large as depicted.

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.)

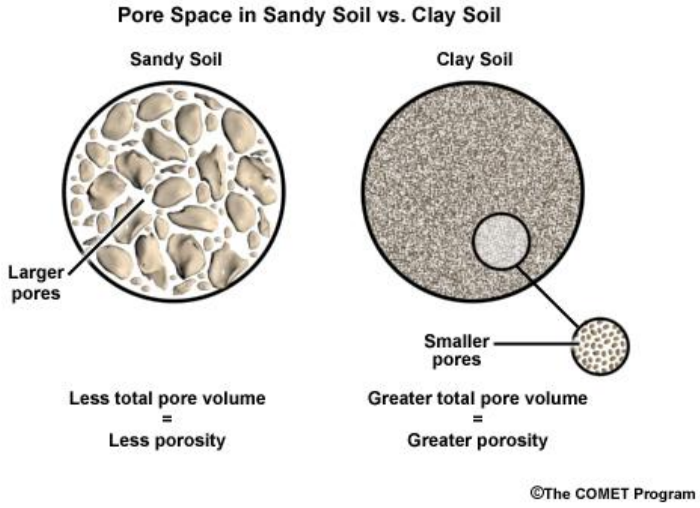
Name: _____ Date: _____

Background

As you discovered in the Soil Texture Investigation, the texture of soil reflects the amount of sand, clay, or *loam* in the soil. Recall that sand has relatively large particles and that clay has miniscule ones. When packed together, these minerals also have different sized spaces, or *pores*, between their particles. Smaller minerals fit more closely together and so have smaller pore spaces. The soil's composition and its *porosity* (the size and amount of pores in it) influence the ability of water to *percolate*, or pass down, through the soil. Interestingly, porosity also affects the soil's capacity to store water. In this activity, you will investigate the percolation rates of sand and clay, as well as two soil mixtures –loam and a school-ground sample. You will draw conclusions about the relationship between porosity and percolation in these soils.

Definition

Loam is soil composed mostly of sand and silt with a smaller amount of clay. It is not predominantly sand, silt, or clay. Loam soils generally contain more nutrients, moisture, and humus than sandy soils. Because of loam's texture, it retains nutrients and water, percolates well, making it an excellent soil for vegetable gardening.



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

Soil Percolation Student

Pre-Lab

Predict water percolation by answering the **A**-lettered questions in the **Percolation Test Chart** (shaded areas).

Lab Procedure

Read the entire procedure before starting. Assign each group member a job: Reader, Timer, Measurer, Pourer, Data Recorder.

1. Balance the bottle top upside down, in a container.
2. Center the window screen and press the screen down inside bottle to cover the opening.
3. Pour 500 milliliters (mL) of soil into the bottle.
4. Fill the measuring cup with 500 mL of water.
5. Start the timer as you start pouring. When you see water leak from the bottom of the bottle, record the time on the data chart. (**Don't stop the timer**.)
6. After 4 minutes, remove the bottle from the container.
7. Measure how much water is in the container. Record this amount on your **Percolation Test Chart**.
8. Make sure that all of the **B** lettered questions are answered for that soil sample.
9. Repeat steps 1- 8 with your other soil samples, if applicable.
10. Record your team's data on the **Class Data Table**.

Percolation Test Chart

A. Prediction B. Observation	Sand	Clay	Loam	School Soil	Explanation
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								
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 reduce water pollution by catching stormwater runoff so that it is used by the garden plants and slowly filter through the garden soil. From these results, how 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?

Name: _____ Date: _____

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 pattern of storm water runoff on your campus.
2. Identify problems, such as eroding hillsides, patches of bare lawn, or trash sources.
3. 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)

Ways to Observe Stormwater Runoff Flow Paths and Problems

Observing stormwater flow is easiest during or after it rains. If this is not possible, your team can determine patterns of stormwater flow by observing:

- Places 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.
- Eroded slopes.
- The direction of water flows when it is poured on a surface.
- Structures on the campus for directing stormwater away from buildings and property (gutters, downspouts, ditches, ponds, rain gardens, or drains).

Field Instructions

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; keep features in proportion as much as possible. Look for the items on the Map Key and record them on your map. You can add items to the key that are not on it.

Field Notes:

Put additional observations here.

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

Follow-up Class Discussion:

Your team should answer these questions, 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.

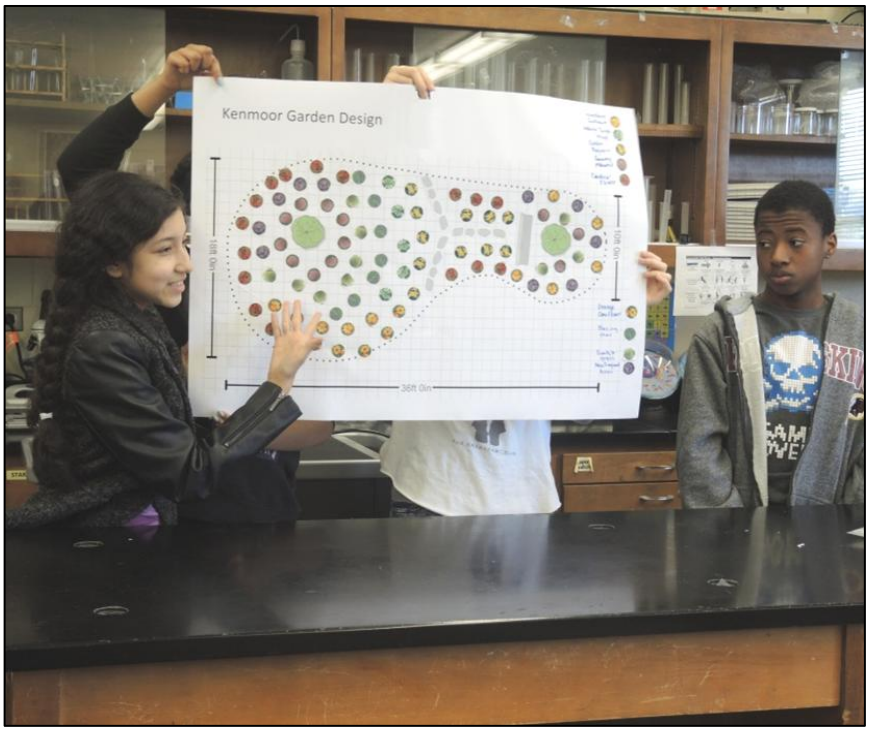
2. Where did most of the stormwater runoff come from?

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?

Planning Your Project

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.

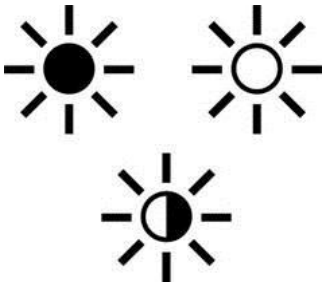
	Site A	Site B	Site C	Comments
Would a project on this site reduce stormwater runoff?				
Would this site support any wildlife-related goals?				
Is it important that the project be visible to students and the public?				
• Does the area have high visibility?				
Is it important that students can get 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.)				

Sun/Shade Observation

Student Handout

Name: _____ Date: _____

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? _____

Sun/Shade Observation

Student Handout

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?

Site Characteristics and Plant Preferences — Student

Name: _____ Date: _____

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
Hardiness Zone (Standard that determines which plants are most likely to thrive at a location, based on winter temperature.)	1 2 3 4 5 6 7 8 9 10 11 12	
Soil What kind of soil does the site have?	Sand Loam Clay	
What is the pH?		
Light How much light does the site get?	○ Full Sun ◗ Part Shade ● Full Shade	
Moisture Is the site dry, moist, or wet, for most of the time?	Dry Moist Wet	

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).

Site Characteristics and Plant Preferences Student

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

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/).

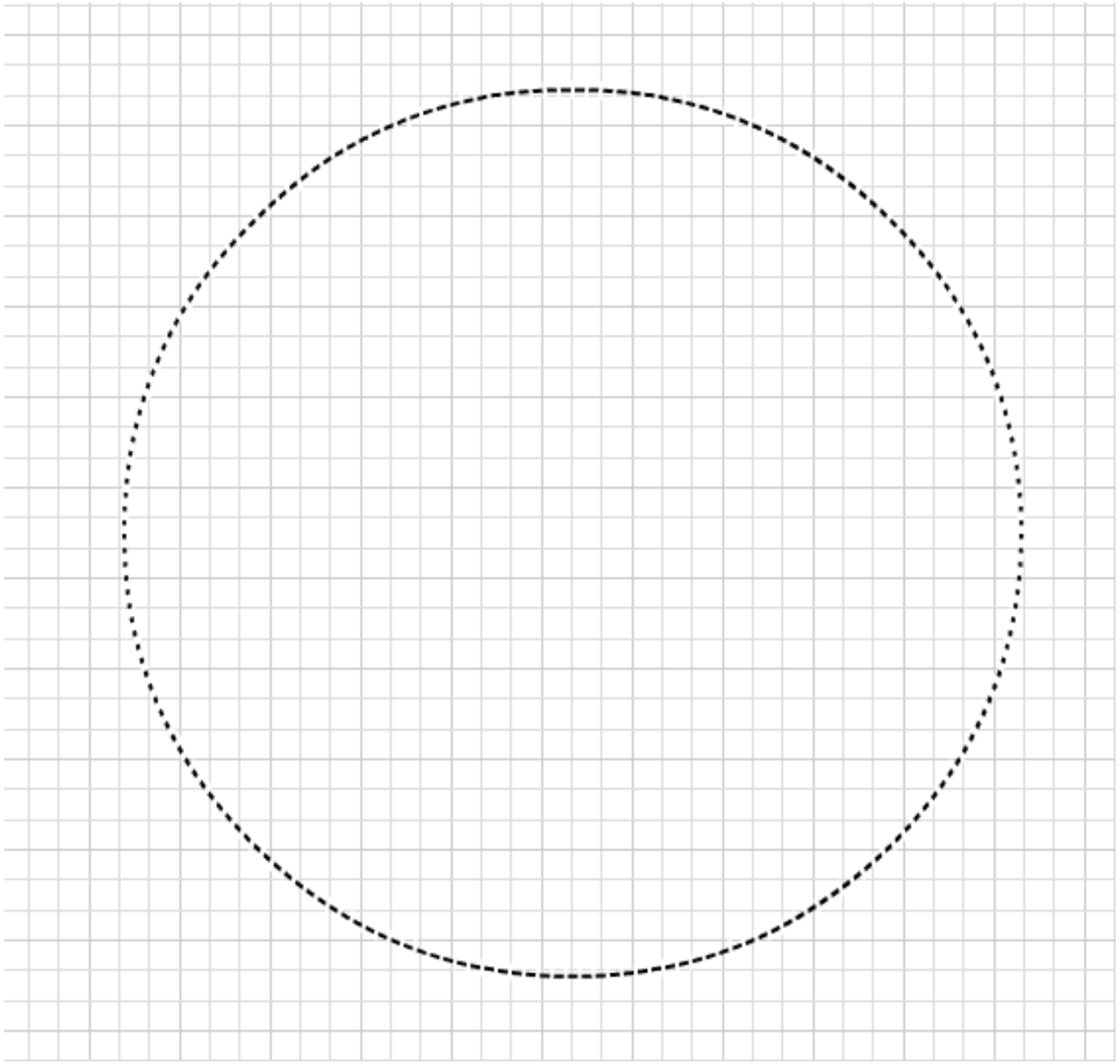
You will start with a sketch of your garden. You will make your sketches and final design on graph paper using colored pencils. This will be a planar view from above. (Some people need to envision their garden from a frontal view first, so if it helps, do that first, sketching in plant sizes and colors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

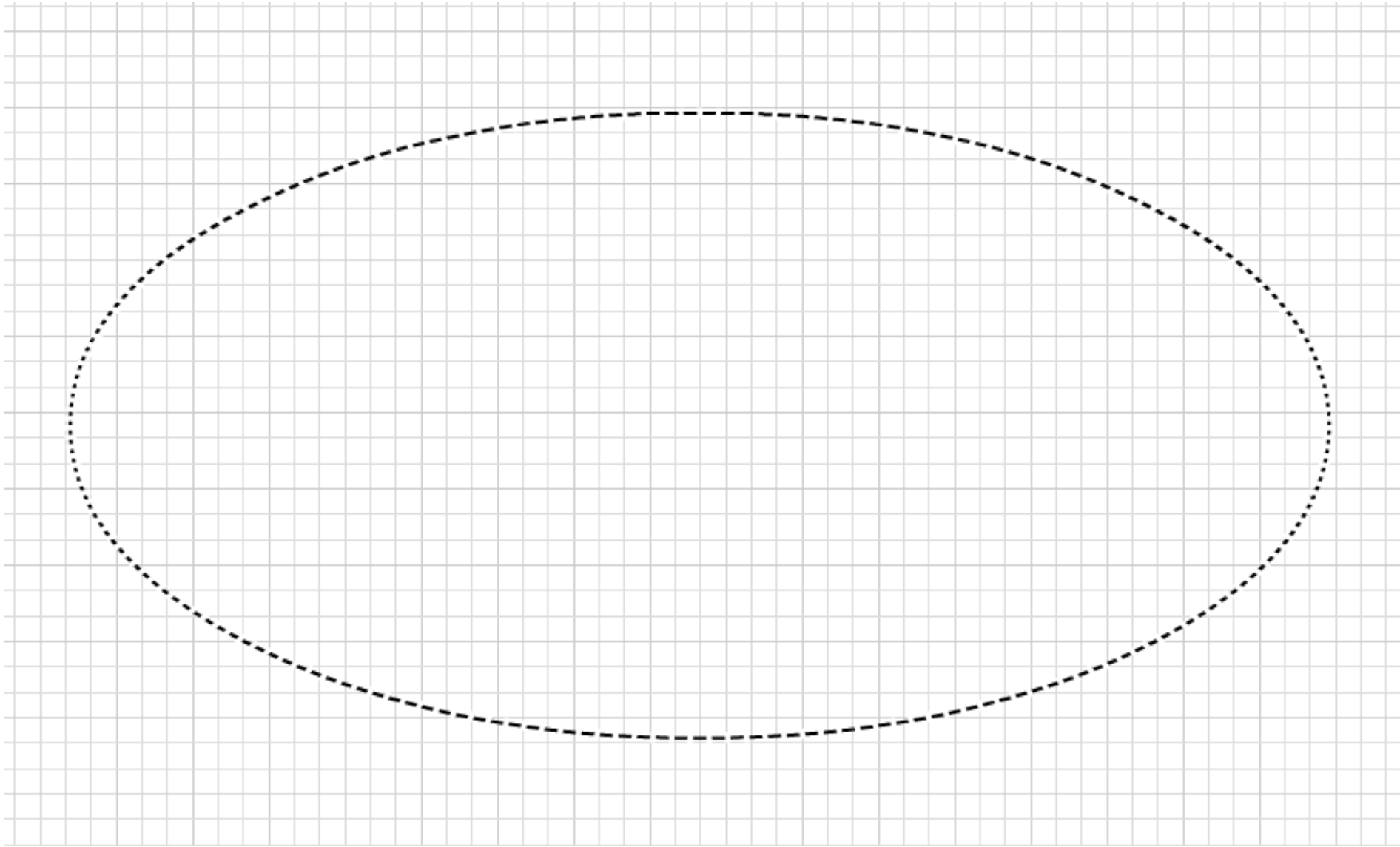
Notes from the Design Presentation Go Here.

Garden Design and Plant Selection

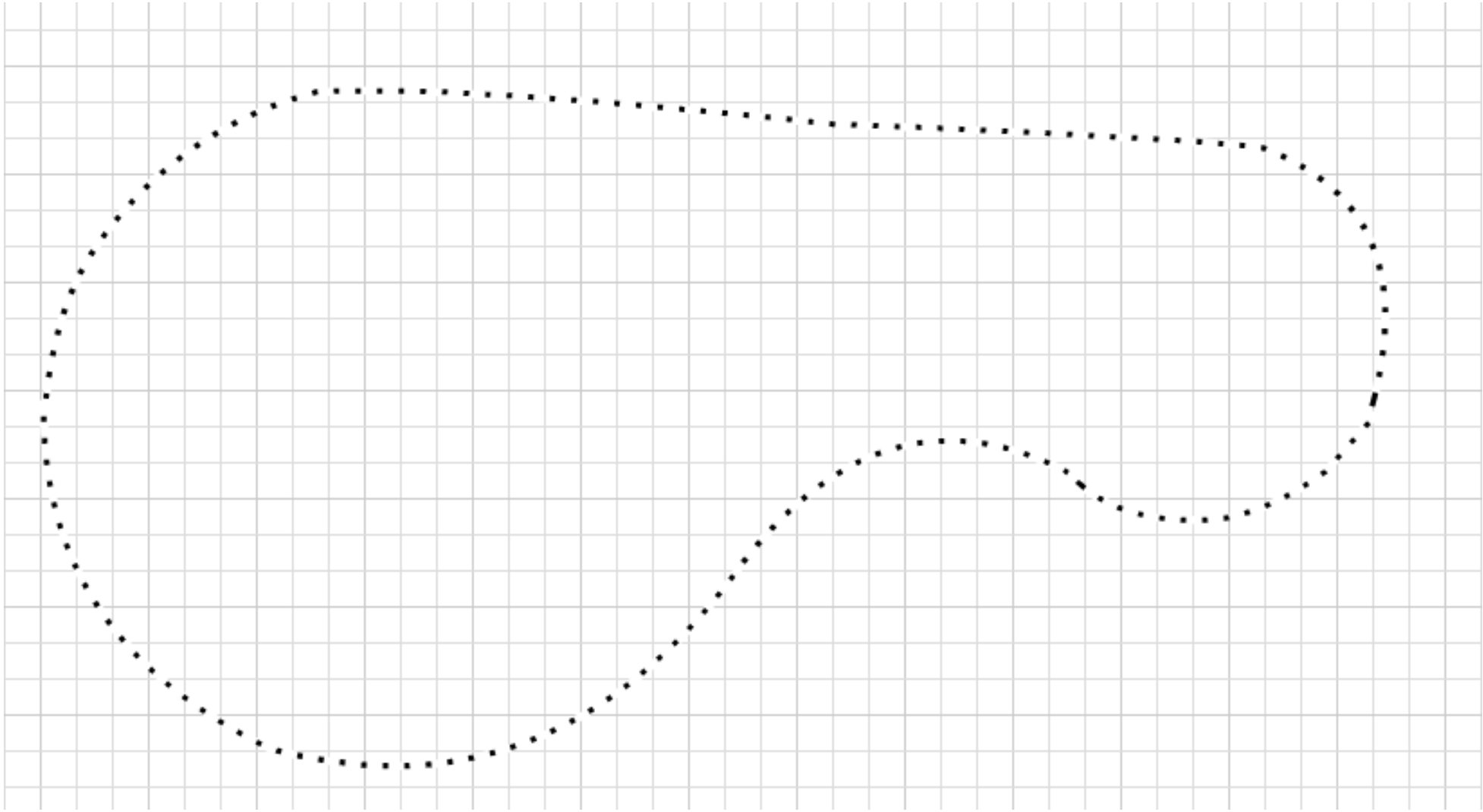


Each square = ___ sq. ft.

Garden Design and Plant Selection



Each square = ___ sq. ft.



Each square = ___ sq. ft.

Maintaining Your Project

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

Maintenance of Your Stormwater Action Project

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[1]												
Apply mulch[2]												
Cut back perennials and grasses[3]												
Watering[4]												
Weeding as needed[5]												
Replace, thin, and add plants as needed[6]												
Snow management[7]												

(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.

Resources

Resources

Gardens

NATIVE PLANT SELECTION AND SOURCES

U.S. Fish & Wildlife Service Native Plants for Wildlife Habitat and Conservation Landscaping Chesapeake Bay Watershed Downloadable PDF: 5.3 MB and is available here. The best place to start for regional native plant research.

Native Plant Center

Missouri Botanical Garden Plant Finder: Excellent resource. Provides details and pictures.

Lady Bird Johnson Wildflower Center: Includes a useful search engine matching site characteristics to plants.

USDA Plants Database: Provides fact sheets about plants with more extensive information on their life-cycles and uses.

Maryland Native Plant Society lists native plant sales, nurseries with native plants

RAIN GARDEN GUIDES

Guidelines for Rain Garden Prince George's County MD

Rain Garden Design and Construction A Northern Virginia Homeowner's Guide

Rain Garden Manual for Schools A How-To Manual For Fayette County Public Schools

Rain Garden Templates Low Impact Development Center. Free templates and a good community resource.

Rainscaping with Rain Gardens…Working with Nature to Transform Stormwater Runoff into Garden Oases

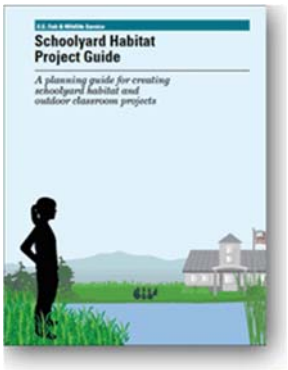
BAY-WISE GARDENING OR CONSERVATION LANDSCAPING

Bay-Wise Gardening University of Maryland Extension: publications and ample information on Bay-Wise Gardening List of Master Gardeners

Conservation Gardening for Stormwater Control residences, Montgomery County Department of Environmental Protection: Includes simple explanation and resource links.

City of Rockville, Maryland: comprehensive list of resources for rain gardens and conservation gardens.

SCHOOL YARD HABITAT



Fish and Wildlife School Yard Habitat web site and Schoolyard Habitat Guide. 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: This site includes a downloadable guide for creating habitat areas. The assessment and planning portions may provide you with ideas. (http://www.nwf.org/How-to-Help/Garden-for-Wildlife/Schoolyard-Habitats/Create/How-To-Guide.aspx)

Resources

Maps

Maryland Land Use Maps
U.S. Topographic Maps
Maryland Department of Natural Resources Streamhealth Maps
National Geographic FieldScope Chesapeake Bay Watershed Project
National Geographic Maryland FieldScope

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

NRCS Soil Education Lesson Plans by Grade Levels

On-Line Soil Biology Primer

Funding Sources (These are just a few of the many funding opportunities.)

Chesapeake Bay Trust: multiple grant opportunities throughout the year

Lowe's Charitable and Educational Foundation: lowes.com/community

The Home Depot Foundation Community Impact Grants

Local civic clubs

Garden centers and local garden clubs

Marylanders Plant Trees: MD Department of Natural Resources provides $25-off tree coupons, vendor lists, and other info.

Prince Georges County Department of the Environmental RainCheck Rebate Program for home owners, religious organization, and others.

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 this properties. Look for the counties' or cities' environmental or land-use departments for this information.