Lesson: Land's Wonders and Worries: Operation Stormwater

Topic/Essential Question: How have humans affected the Chesapeake Bay and its watershed?

Unit/Lesson Sequence: This lesson is one of two in the "Land's Wonders and Worries" module based at Arlington Echo Outdoor Education Center. The lesson focuses on the impacts of pervious versus impervious surfaces on stormwater control.

Content Standards:

- **Environmental Literacy**
  5.A.1. Analyze the effects on human activities on earth's natural processes
  1.A.5.f. Make recommendations supported by data to help address or resolve the issue.
  8.F.1.b. Identify actions that can be taken as individuals and those that require the involvement of other people, organizations and government.
- **Social Studies**
  3.D.1.b Geography Describe ways and reasons people in Maryland and the U.S. modify the natural environment and the consequences of modifications.
- **Science**
  6.4.B.1. Recognize and describe that people in Maryland depend on, change, and are affected by the environment.
  2.4.A.2.b. Cite evidence to show that erosion shapes and reshapes the earth's surface as it moves from one location to another.
- **Math**
  Common Core 3.MD Geographic measurement: understand concepts of area and relate area to multiplication and to addition.

Length of Lesson: 35 minutes

Student Learning Outcome: The student will investigate the Arlington Echo surfaces pictured on the map and evaluate their effectiveness in infiltrating rain water.

Knowledge of the Learner:

- Prerequisite knowledge, skills and processes: When rain hits impervious surface, it runs off into storm drains. Students should be able to listen to instruction and follow directions.
- Student needs, interests, previous learning: These will be identified in the pre-assessment.
- Conceptual difficulties: All students should be able to differentiate between some of the surfaces but some group discussion may be required to find all the stormwater controls. Students may work in pairs or small groups to identify and label these.
- Differentiation: Students are 4th grade, with a diversity of backgrounds and skill levels.

Knowledge of the Content

At the beginning of the lesson, students work with the activity leader to create a thinking map of their knowledge. This creates a base on which they can root their findings. The activity leader can refer back to the map at the end of the lesson to reinforce the students' findings. Students will work in pairs or small teams to find ways to control stormwater. They may discuss their findings along the way to improve understanding and encourage cooperation. Students will use their knowledge of stormwater controls to investigate the area. This includes application of the knowledge. After investigation, students will evaluate the effectiveness of stormwater controls and their self-efficacy.

- **Vocabulary:**

Stormwater	Watershed	Runoff	Pervious
Impervious	Erosion	Rainscape	Green Roof
Rain Barrel	Bioretention Area	Infiltration	Sandstone
Pervious Concrete	Vernal Pool	Swale	

- **Resources:**

Clipboards	Map worksheets	Blue and pink highlighters
1 large bucket of water	Small blue buckets	Measuring cups
Easel	Thinking map poster	Thin dry erase marker
Roofing tile sample	Green roof sample	2 large metal cans (top and bottom removed)

- **Supplements:**
  A: Background for Activity leader: Information on Stormwater
  B: Operation Stormwater Thinking Map
  C: Operation Stormwater Investigative Journal Map
  D: Operation Stormwater Key Terms

Lesson setup:

1. Fill large bucket by the boat house with water from the rain barrel (or from spout on the side of the maintenance building if the rain barrel is empty), students will use this to fill their blue buckets.
2. Set out the blue buckets about halfway filled with water and place a measuring cup inside each (1 per every 2 students).
3. Pair the clip boards with highlighters (one pink and one blue each) on the picnic table.
4. Set up easel with Thinking Map Poster, thin marker, and wipe cloth by the picnic tables.
5. Place the two large cans in two different areas: one in a grassy area of the field and one in the forest.
6. Refer to **Supplement A** for background information on stormwater prior to the lesson.

Instructional Delivery

Pre-Assessment:

1. Have students sit at picnic tables facing the easel and thinking map poster

2. Ask students to define stormwater and discuss responses to create a definition *(stormwater is precipitation from any major storm event).*
3. Continue by asking students if anyone knows what a watershed is *(a watershed is the area of land where all the rivers and streams flow across and into a large body of water;* ex: we are in the Chesapeake Bay watershed).

Motivation/Warm-up:

1. In this activity, the students will be looking at the movement of stormwater across different surfaces in a watershed. Explain that water runs over 2 main types of surfaces in a watershed: PERVIOUS and IMPERVIOUS.
2. Ask students for a definition or guess of what pervious and/or impervious means. If the students do not have any guesses, tell them the definition for pervious (*a surface that absorbs water)* and ask them to use that to come up with a definition of impervious (*a surface that does not absorb water).* Write both definitions on the thinking map **(Supplement B)**.
3. Ask students which type of surface (pervious or impervious) is better for protecting the health of the Chesapeake Bay and discuss their answers to reach a consensus within the group. (*Pervious is better because it slows down and soaks up water to control stormwater runoff. Stormwater runoff can carry pollutants into the bay and can cause erosion and flooding.)*
4. Complete the thinking map as a group, asking the students to make educated guesses about which surfaces are PERVIOUS and IMPERVIOUS. It is important to write down what the students say, whether or not it is the correct answer. The map will be revisited at the end of the lesson and corrected if needed. If the students have trouble coming up with surfaces, give them one or two examples for each type of surface to generate ideas **(examples in Supplement B)**.

Procedure:

Impervious surface mapping:

1. Ask chaperones to pass out the students' journals and have students turn to the Operation Stormwater Map **(Supplement C)**. Point out that the map is gridded, and explain that the group will investigate the surfaces labeled on the map to find out whether they are pervious or impervious. Have students mark the "Surface Type" key boxes—pink for impervious, blue for pervious.
2. Divide the students into groups of 2-3. Tell the students that they will work with their pair or small group to investigate the pervious and impervious surfaces labelled on the mapped area of the Arlington Echo's campus. Each group needs one clipboard and map, a blue highlighter and pink highlighter, a blue bucket and a measuring cup.
3. Using the compass rose on the road next to the boat house, help the students orient themselves to the directions on their map.
4. Direct students to test the various surfaces labelled on the map using one of the two variations below:

Variation A:

- As a whole group, guide the students on a tour around the various test sites.
- At each site, ask the students to make a prediction as to whether the surface is pervious and impervious **(Supplement D)**.
- Let the students know that they are acting as scientists! They should fill the measuring cup halfway and then pour water onto the surfaces to determine if they are pervious or impervious.
- Explain what the site is, what is happening to water as it flows through or over the surface, and how it controls or does not control stormwater flow.
- Remind students to mark the feature on their map as pink for impervious or blue for pervious.

Variation B: **This variation requires students to work independently with their pair or small group to self-navigate and investigate surfaces. If you do not feel confident that the students will succeed without activity leader guidance, do not choose this variation.*

- Briefly walk the students to the various test sites and explain what they are (green roof, rain garden, bio-retention area, etc.) **(Supplement D)**
- In pairs or groups, students will disperse to investigate the surfaces pictured on the map using the blue buckets and measuring cups. Let the students know that they are acting as scientists! They should fill the measuring cup half way and then pour water onto surfaces to see if they are pervious or impervious.
- Remind students to mark their findings on their maps (blue for pervious, pink for impervious).
- Chaperones and the lesson activity leader should walk between groups to help orient students and answer questions as they test different sites, pointing out various infiltration practices.
- Ask students and chaperones to return to the picnic tables by the boat house approximately 10 minutes before the lesson is set to end to allow time for the infiltration measuring and assessment.

Rate of Infiltration Measuring: ***For **Variation A this will take place after the bio-retention area when students pass the can in the field across from the dining hall; for **Variation B** this will take place after small groups or pairs have tested surfaces on their own.

1. Gather the students around the large can in the field.
2. Define Infiltration *(the passing of water into and through the soil).* Invite students to hypothesize the rates of infiltration at the field as compared to the forest.
3. Ask two volunteers to pour 1/2 cup water into the field can and have students count aloud to see how many seconds it takes for the water to completely soak into the ground.
4. After testing the field, lead students to the large can in the forest.
5. Ask two different volunteers to pour the same amount of water (1/2 cup) into the forest can and again have students count aloud to see how long it takes for the water to completely soak in.
6. Ask students to compare the infiltration rates and discuss the implications. (The forest can will drain much faster because the soil is not compacted and the land cover is tree, roots and leaves—this means that a forest is more effective at managing stormwater, especially in a heavy rainfall, even though both surfaces are pervious)

Assessment:

1. Have students return to the picnic tables to complete checking off their maps (marking pervious and impervious surfaces) and discuss their findings.
    - Have the students count the blue (pervious) and pink (impervious) boxes on their maps and write the totals on their journal page. They should write a simple ratio of this number.
2. Use the following questions to assess the students' knowledge and lead the discussion:
    - Which location allowed water to drain quicker, the field or the forest?
    - Why? (What do the infiltration rates indicate?)
    - How many blue blocks did they count? How many blocks were colored pink?
    - How do the blue-colored stormwater controls help to infiltrate water?
    - Which color do we want to see more of, blue or pink?
    - What are some things that we could do as Chesapeake Stewards to have more pervious surfaces, or to help slow down and soak in rain water runoff?
    - Can any rainscaping projects be done to create more pervious surfaces around your school or home?
3. Re-examine the thinking map of pervious/impervious and make changes as needed.

Module Debrief: After the two lessons in Land's Wonders and Worries have been completed, students will participate in a game, led by an AE staff member, which exemplifies stormwater movement.

Notes for inclement weather:
Arlington Echo encourages keeping students outdoors whenever possible—even in the rain.
If it is raining or cold the group might meet inside the Boathouse or West Cabin to get some protection from the weather during the pre-assessment and then move outside for the activity. In the case of severe weather, (thunder, extreme cold, etc.), the alternative lesson: Watershed Model, will be taught in the Boathouse or West Cabin unless directed otherwise by the Arlington Echo Staff. The materials and lesson will be provided at that time.

Notes for Clean up
Please organize and return the lesson folder, poster and materials into the Boathouse. Remember to inform the Arlington Echo Staff if you need assistance or if any materials are damaged or missing.

Supplement A

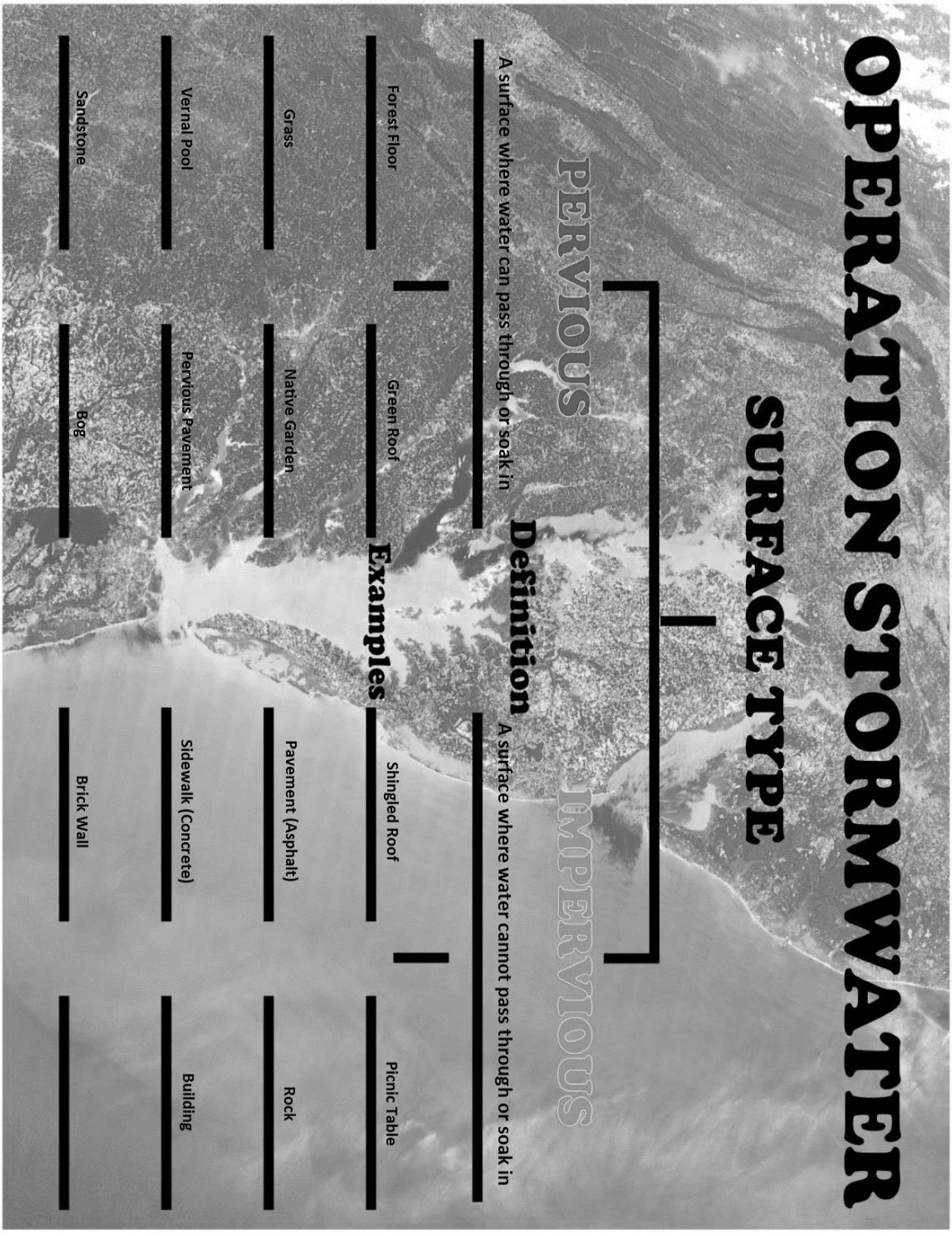
Information on Stormwater

Stormwater is one of the biggest environmental problems in the Chesapeake Bay watershed. The more we build over the land, the more stormwater gets displaced and cannot infiltrate into the ground. The displaced water then runs over and erodes the land, carrying pollutants and sediment to the rivers and streams that feed the Bay. The overloaded stormwater systems often flood the streams that were once ecologically balanced and place them under tremendous stress. They become deep gullies which encourage further erosion during storm events. Impervious surfaces do not allow water to infiltrate into the ground or only allow it to infiltrate very slowly. Anything paved or compacted may be considered impervious. Lawns are usually impervious due to the tight compaction and very short root structure!

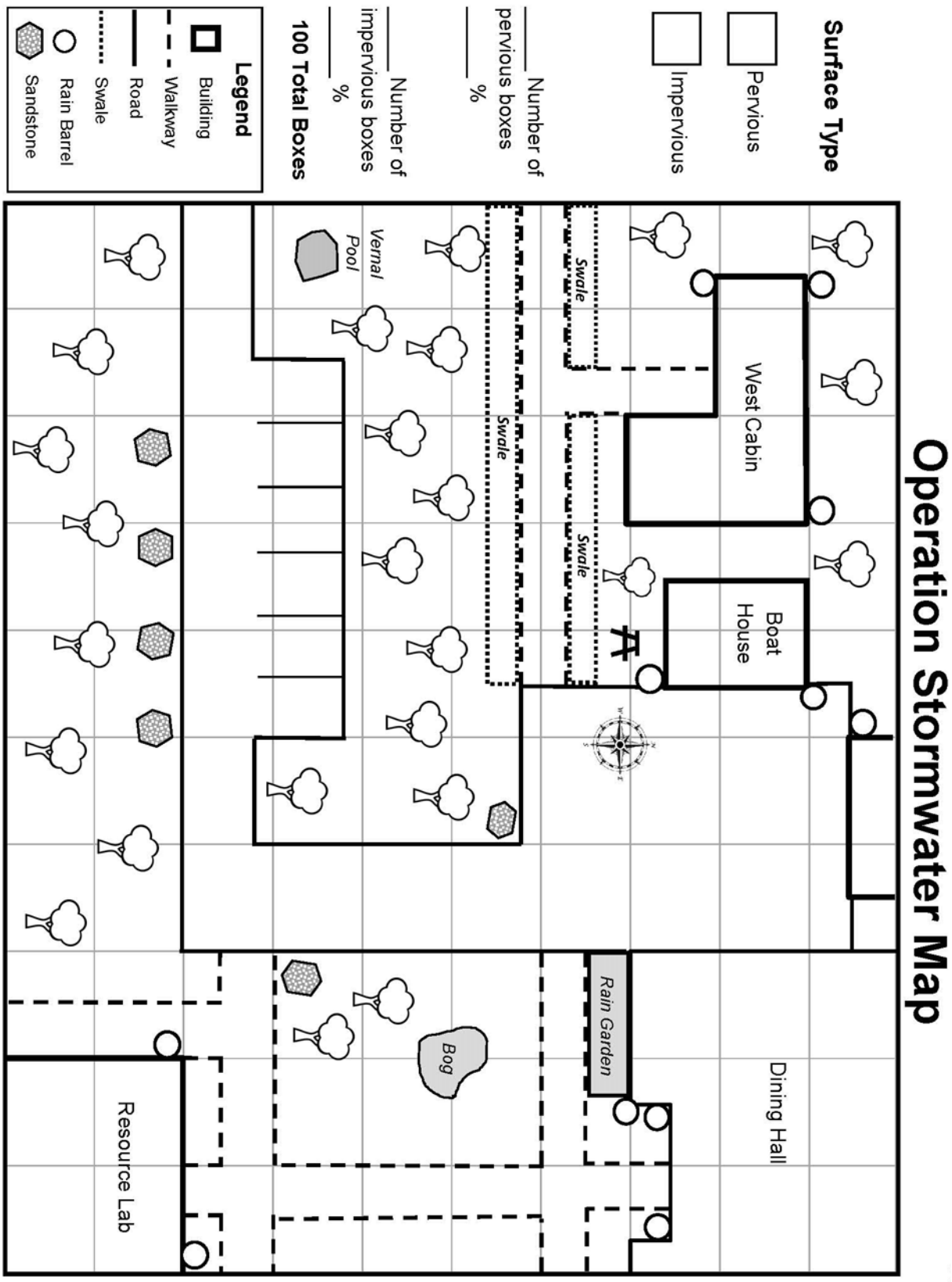
Nature provides many natural systems that control stormwater. These systems are mainly wetland areas such as bogs, vernal pools, wet meadows, ponds, and marshes. Wetlands are able to retain and infiltrate much more water than dry areas and are thus extremely important to the environment. The most effective approach to controlling stormwater is to catch it and have it soak into the ground as early as possible. It is much easier to control stormwater at the source than it is downstream. Unfortunately, many natural wetlands are filled in and paved over for shopping malls, apartment complexes, and other impervious features that do not control stormwater as effectively.

We can mimic these natural features to control stormwater in urban areas using a landscaping method known as Rainscaping. Rainscapes capture and slow stormwater so that it may infiltrate the ground more effectively. Some examples of rainscapes include: green roofs, rain barrels, swales, pervious pavement, rain gardens, and human-made bogs, ponds, and other bio-retention areas. All of these human-made systems allow stormwater to be slowed to flow into the ground even in high-traffic areas. Schools and residences can have a big impact on the health of our waterways and the Bay by installing rainscapes to trap and manage their stormwater on their site.

Supplement B



Supplement C: Investigative Journal Page



Supplement D

OPERATION STORMWATER KEY WORDS

Stormwater- water from any major storm event

Watershed- the area of land where all rivers and streams flow across and into a large body of water

Runoff- the flow of water from rain, snow melt or other sources over the land; it can carry pollutants with it as it moves

Pervious Surface- a surface that absorbs water

Impervious Surface- a surface that does not absorb water

Erosion- the washing away of soil by the flow of water

Rainscape- a landscape designed to control stormwater runoff

Green Roof- a roof of a building that is covered with soil and vegetation

Rain Barrel- a barrel used to collect and store rainwater runoff, typically from rooftops via rain gutters

Bioretention Area (bog)- an area designed to collect and slow the flow of water so that it can infiltrate into the soil

Infiltration- the passing of water into and through the soil

Sandstone- a naturally-occurring pervious sedimentary rock composed of sand-sized minerals and/or rock grains

Pervious Concrete- a man-made porous concrete paving material

Vernal Pool- a pool that is seasonally filled with water—typically wet in the spring (vernal means "spring" in Spanish) and dry in early autumn—providing habitat for specific wetland plants and animals excluding fish. Vernal pools collect and slow the flow of water so it can infiltrate into the soil, similar to a bio-retention area.

Swale- a low-lying stretch of land that slows, captures, and controls runoff by spreading stormwater horizontally. Swales can be naturally occurring or man-made, and filled with grass, plants, stones, or a combination of the three.