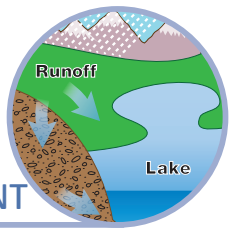
Discovering the Connection:

Your Environment, Your Health

Afterschool Science Club Curriculum for Middle School Students



Unit 5: Runoff, Impervious Surfaces, and Smart Development

Developed by K-12 Specialized Information Services group,
National Library of Medicine, National Institutes of Health

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About Discovering the Connection: Your Environment, Your Health

Purpose of the Curriculum

Discovering the Connection: Your Environment, Your Health uses the Tox Town Web site (toxtown.nlm.nih.gov) developed by the National Library of Medicine (NLM) to introduce middle school students to environmental health issues in everyday life. The curriculum includes information and laboratory research and communication activities, stressing the relevance of science to informed citizenship and integrating science, society, and literacy. The curriculum is for an afterschool club, but can also be used in the science classroom. The curriculum is based on National Science Education Standards.

Teaching and Learning Approaches

The curriculum uses inquiry-based learning and problem-based learning approaches. These are student-centered approaches that promote in-depth understanding and critical thinking by fostering students' active engagement with the subject matter. Students develop content knowledge and scientific reasoning skills through collaborative work on real world problems. They explore ideas, formulate meaningful questions, collect and analyze data, and evaluate and communicate their findings.

Tox Town Web Site

Tox Town (toxtown.nlm.nih.gov) is visually engaging and is an authoritative, reliable educational Web site, dedicated to highlighting the connections among chemicals, the environment, and the public's health.

Curriculum Development Team

This effort was initiated and coordinated by the NLM K-12 Specialized Information Services group. The NLM, one of the institutes of the National Institutes of Health (NIH), has been a center of information innovation since its founding in 1836. The K-12 group develops authoritative resources for a variety of science education areas, coordinates outreach to educators and school health professionals, and conducts research into teaching and learning.

The working group for this curriculum consists of: the NLM K-12 staff; Daniel M. Levin, a professor of science education from the University of Maryland College of Education; and five teachers from Montgomery County, MD, and the District of Columbia. The teachers are Jacquelyn Geer (science), Maura Hinkle (science), Sandra Garner (language arts), Kelley Knox (social studies), and Berneatta Barnes (science).

Curriculum Overview and Suggested Use

The curriculum contains six units. Each unit introduces one environmental health topic and includes three or four 50-60 minute lessons in the following format:

- Topic introduction and information research activity using Tox Town;
- Hands-on experiment or activity reinforcing understanding, conducted with simple materials; and
- Communication and social action activity where students share their understanding of the topic with others and translate their understanding into actions.

The units can be used sequentially or individually to support the existing middle school science curriculum. They can also be used to support the science/society connection in the social science or language arts classroom. The entire curriculum was pilot-tested as an afterschool club at the Cabin John Middle School, Montgomery County, MD.

The Six Units of the Curriculum

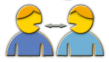
1. ***Water Quality:*** Introduces students to drinking water quality issues and the water treatment process. Includes experiments where students test school drinking water, compare it with water from other sources, and communicate the findings to the school community.
2. ***Air Quality:*** Introduces students to air quality issues and the impact of air pollution on human health. Students test air quality in several locations in and around the school.
3. ***Chemicals in Your Home:*** Informs students about potentially toxic chemicals in common products and introduces safer alternatives.
4. ***Food Safety:*** Introduces students to biological, chemical, and physical contaminants in food. Uses an experiment to teach safe food handling.
5. ***Runoff, Impervious Surfaces, and Smart Development:*** Introduces students to the relationship among runoff, water pollution, and human health. Also introduces the idea of responsible development.
6. ***The Great Debate: Bottled Water vs. Tap Water in Our School:*** Students perform research about pros and cons of different sources of drinking water, engage in a debate, and develop persuasive arguments to advocate for bottled or tap water as a primary source of drinking water in the school.

Symbols Used in This Curriculum

 – information research via Tox Town

 – lab experiment

 – hands-on activity

 – communication and social action activity

 – excerpt from student handouts in teacher directions

Unit 5: Runoff, Impervious Surfaces, and Smart Development

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Runoff, Impervious Surfaces, and Smart Development

Unit Overview

This unit uses the Tox Town Web site (toxtown.nlm.nih.gov) developed by the National Library of Medicine to introduce students to environmental health issues in their everyday life through *inquiry-based learning* and *problem-based learning* approaches. Inquiry-based learning is a student-centered approach that promotes in-depth understanding and critical thinking by fostering students' active engagement with the subject matter. Students explore ideas, formulate meaningful questions, collect and analyze data, and evaluate and communicate their findings. Problem-based learning is another student-centered approach, where students develop content knowledge and scientific reasoning skills through collaborative work on real world problems.

National Science Education Standards

H.F.3 Natural Resources

a. Human populations use resources in the environment in order to maintain and improve their existence. Natural resources have been and will continue to be used to maintain human populations.

H.F.4 Environmental Quality

Natural ecosystems provide an array of basic processes that affect humans. Those processes include maintenance of the quality of the atmosphere, generation of soils, control of the hydrologic cycle, disposal of wastes, and recycling of nutrients. Humans are changing many of these basic processes, and the changes may be detrimental to humans.

Unit Objectives

At the end of this unit, students will be able to:

- Communicate how impervious surfaces play a role in water absorption
- Explain how runoff affects environmental health
- Explain how urban sprawl affects runoff and water pollution
- Explain how smart development benefits the environment and human well-being

Essential Questions

How does an impervious surface affect the amount of water transported by runoff?

How does runoff affect the environment and human health?

How does smart development benefit the environment and human well-being?

Technology Education Skills

Students will use computer resources to explore how runoff and impervious surfaces affect environmental health.

L 5.1 Runoff in the Right Direction

L 5.1.1 Objectives, Materials, and Teacher Preparation

Objectives

Students will be able to:

- Explain the relationship between runoff and impervious surfaces
- Explain how urban sprawl contributes to runoff
- Identify ways in which runoff affects the environment and human health

Materials Needed for Lesson

- *Runoff and Impervious Surfaces Definition Cards* (H 5.1.1)
- *Stormwater Runoff Video Organizer* (H 5.1.2)
- *Runoff Crossword Puzzle* (H 5.1.3)
- Computers with Internet access
- Chart paper (optional)

Teacher Preparation

1. Prepare copies of *Runoff and Impervious Surfaces Definition Cards* (H 5.1.1), *Stormwater Runoff Video Organizer* (H 5.1.2), and *Runoff Crossword Puzzle* (H 5.1.3). You will need one set of handouts per student.
2. Ensure access to computers with Internet connection (for accessing Tox Town, toxtown.nlm.nih.gov).

L 5.1.2 Activator

Teacher Directions

1. Distribute *Runoff and Impervious Surfaces Definition Cards* (H 5.1.1).
2. Referring to the cards, discuss the definitions of the terms *runoff*, *impervious surfaces*, and *urban sprawl* with the students.

> *Runoff* is water from rain or melted snow that is not absorbed or held by the soil, but runs over the ground and through loose soil.
>
> *Impervious surfaces* are paved or hardened surfaces that do not allow water to filter through.
>
> *Urban sprawl* is the increased development of land in suburban and rural areas. It is characterized by single-family homes that are not joined together. These residential areas are also separate from areas where people work and shop, which causes increases in air pollution, water pollution, and the use of cars.

3. Ask students to describe the relationship between impervious surfaces, runoff, and urban sprawl.
4. Write student responses on the white/black board or chart paper.

L 5.1.3 Activity

Teacher Directions

Part 1: Stormwater Runoff Video and Discussion

1. Distribute *Stormwater Runoff Video Organizers* (H 5.1.2).
2. Show students the following video about stormwater runoff:

   Link: *Bay 101: Stormwater Runoff* (Chesapeake Bay Program) - chesapeakebay.net/videos/clip/bay_101_stormwater_runoff
3. While viewing the video, students should answer the questions found on *Stormwater Runoff Video Organizer* (H 5.1.2).

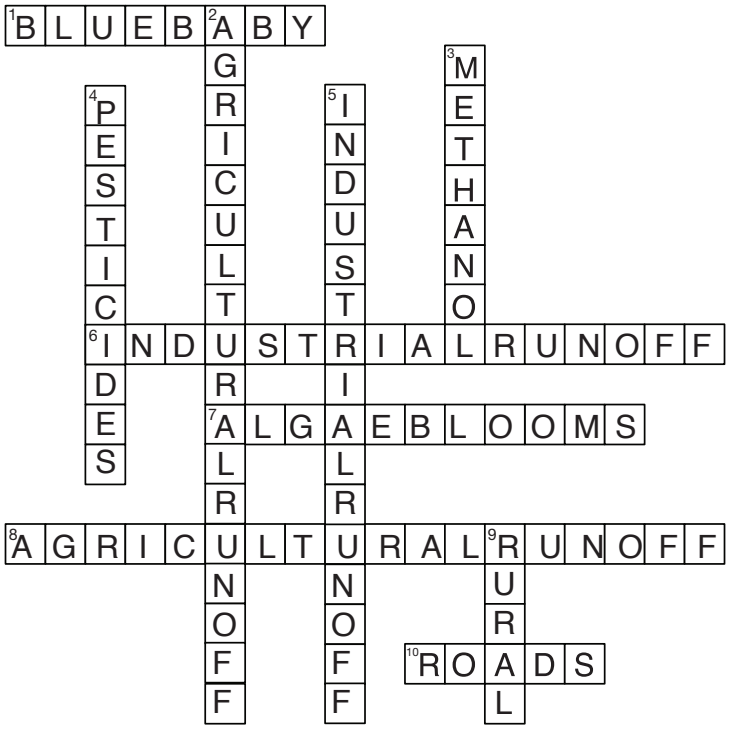
   - How do impervious surfaces contribute to stream pollution?
   - How does runoff affect a stream's habitat?
   - How can we reduce pollution from runoff?

4. After viewing the video and answering the questions, have students share their responses.

Part 2: Crossword Puzzle with Tox Town

1. Distribute *Runoff Crossword Puzzle* (H 5.1.3).
2. Instruct students to use Tox Town (toxtown.nlm.nih.gov) to complete the crossword puzzle. Refer to the answer key below.

L 5.1.3.1 Runoff Crossword Puzzle Answer Key



L 5.2 Impervious Surfaces Lab 

Note: This lab is designed to be done outside on various surfaces.

L 5.2.1 Objectives, Materials, and Teacher Preparation

Objectives

Students will be able to:

- Identify different types of surfaces and explain how they absorb water
- Explain how surface absorption affects runoff
- Model water runoff on various surfaces

Materials Needed for Lesson

Handouts

- *Impervious Surfaces Lab Instructions* (H 5.2.1)
- *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2)
- *Graph Paper* (H 5.2.3)
- *Impervious Surfaces Lab Rubric* (H 5.2.4)

Materials for the Lab

- Graduated cylinders or beakers (one per group)
- Measuring bottles prepared by the teacher - see below (two per group)
- Stopwatch (one per group)
- Plumber's putty - can be purchased in any hardware store
- Metal spoons (one per group)
- Scissors (one per group)
- Water

Materials for Preparing Measuring Bottles

- Graduated cylinder
- Small, sturdy, clear recyclable plastic containers with not-too-narrow necks (e.g., individual-portion-size milk or juice bottles)
- Permanent marker
- Water

Teacher Preparation

1. Prepare measuring bottles in the following way:
   A. Collect small, sturdy, clear recyclable plastic containers with not-too-narrow necks (e.g., individual-portion-size milk or juice bottles). These will be used to funnel water onto various surfaces.
   B. Remove the labels.

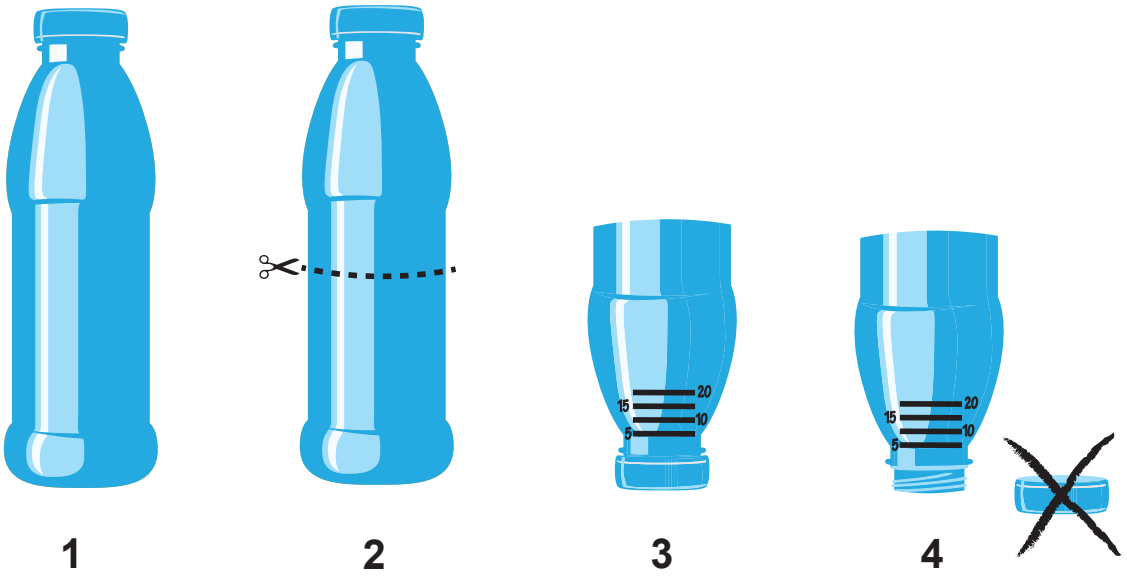
C. Cut the bottom off the containers (see picture).

D. Create graduated marks for reading water levels by performing the following steps with each bottle:

1. Leave lid on the container and turn the container upside down so the lid is set on the table.
2. Using graduated cylinder, pour 5 ml of water into the container, and mark water level on the outside of the container with a permanent marker. Label "5 ml."
3. Add another 5 ml of water to the container, mark water level on the outside of the container, and label "10 ml."
4. Create "15 ml" and "20 ml" marks in the same manner.
5. Repeat procedures with each container.
6. Remove lids from the containers.

2. Assemble lab materials.
3. Prepare copies of the handouts (one set per group).

Measuring Bottles Preparation



L 5.2.2 Activity

Teacher Directions

1. Divide students into groups.
2. Distribute the handouts for this activity (one set per group).
3. Instruct students to look at *Impervious Surfaces Lab Instructions* (H 5.2.1). Discuss the purpose of the lab with the students (see first page of the handout):

> This lab will investigate how three common surfaces – mulch, grass, and concrete pavement – affect the amount of materials or pollutants that are carried to our bodies of water.

4. Announce the testable question and ask students to make predictions.

> **Testable question:** What type of surface will absorb the most water in one, three, and five minutes? The least water?

5. Ask students to identify the independent variable (type of surface) and the dependent variable (amount of water absorbed in the specified time, or absorption rate) in the experiments.
6. Distribute materials, or ask student groups to assemble materials for the lab.
7. Discuss the procedures with the students.

Mulch surface

1. Pour 20 ml of water into a beaker or a graduated cylinder.
2. Place the bottle on the mulch in upside down position (see picture).
3. Twist the bottle into the mulch so it can stand securely on its own.
4. Pack mulch around the neck of the bottle to make a seal.
5. Pour the water from the beaker of the graduated cylinder into the bottle.
6. Use a stopwatch to record how much water is in the bottle after one, three, and five minutes. Record your observations on the *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2).
7. Collect your materials to re-use them on the next surface.

Grass surface

1. Pour 20 ml of water into a beaker or a graduated cylinder.
2. Use scissors to trim grass to about 0.5 inch. ***Note:*** The roots of the grass are still beneath the surface.
3. Place the bottle into the grass in upside down position (see picture).
4. Twist the bottle in the grass so it can stand securely on its own. Use the spoon to pack dirt around the bottle's neck.
5. Pour the water from the beaker of the graduated cylinder into the bottle.

6. Use a stopwatch to record how much water is in the bottle after one, three, and five minutes. Record your observations on the *Impervious Surfaces Lab Results Recording Sheet* (H. 5.2.2).

7. Collect your materials to re-use them on the next surface.

Concrete pavement surface

1. Pour 20 ml of water into a beaker or a graduated cylinder.

2. Place the bottle on the sidewalk in upside down position (see picture).

3. Work putty around the neck of the bottle to make a seal between the bottle and the pavement. Make sure the edge of the seal is very tight so the water cannot seep out of the bottle.

4. Pour the water from the beaker of the graduated cylinder into the bottle.

5. Use a stopwatch to record how much water is in the bottle after one, three, and five minutes. Record your observations on the *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2).

8. Ask students to carry out the experiments and record the results on the *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2).
9. Ask students to create line plots on the *Graph Paper* (H 5.2.3).
10. Ask students to complete the *Impervious Surfaces Lab Rubric* (H 5.2.4).
11. Invite students to discuss the following question: What can we do for our towns and cities to help decrease water pollution from runoff?

L 5.3 Smart Development Community Design – Day 1

Note: **Smart Development Community Design** is a two-day activity. The objectives included in this lesson are for both days of the activity; the rest of L 5.3 Smart Development Community Design – Day 1 is unique to Day 1.

L 5.3.1 Objectives, Materials, and Teacher Preparation

Objectives

Students will be able to:

- Research characteristics of smart development communities
- Create a map of a smart development community
- Identify the environmental and health benefits of smart development communities
- Explain how smart development communities affect the amount of pollution from surface water runoff

Materials Needed for Lesson

- Regular paper (for creating drafts)
- Large poster paper (one per group)
- *Smart Development Background Research* (H 5.3.1) (one per group)
- *Smart Development Community Map Organizer* (H 5.3.2) (one per group)
- Computers with Internet access
- Markers/crayons/colored pencils

Teacher Preparation

1. Prepare copies of *Smart Development Background Research* (H 5.3.1) and *Smart Development Community Map Organizer* (H 5.3.2).
2. Ensure access to computers with Internet connection (for accessing Tox Town, toxtown.nlm.nih.gov).

L 5.3.2 Activity

Teacher Directions

1. Divide students into groups.
2. Distribute one *Smart Development Background Research* (H 5.3.1) to each group. Explain the objective of the task by discussing the directions that are listed below. Explain that once students design their community maps, they will present them to others.

Directions: Research the following links to gather information about smart development communities and answer the questions below in the space provided. You will use this information later in order to design your own smart development community.

Link: Smart Growth (Environmental Protection Agency) – epa.gov/dced/topics/index.htm

Link: Designing and Building Healthy Places (Centers for Disease Control and Prevention) – http://www.cdc.gov/healthyplaces/

Link: Urban Sprawl (Tox Town, National Library of Medicine) - toxtown.nlm.nih.gov/text_version/locations.php?id=61

Link: This Is Smart Growth (Smart Growth Network)- smartgrowth.org/pdf/this_is_smart_growth.pdf

3. Announce the time allocated for the activity (25 to 30 minutes) and instruct the students to conduct their research in groups, writing down their answers to the five questions included in the handout:

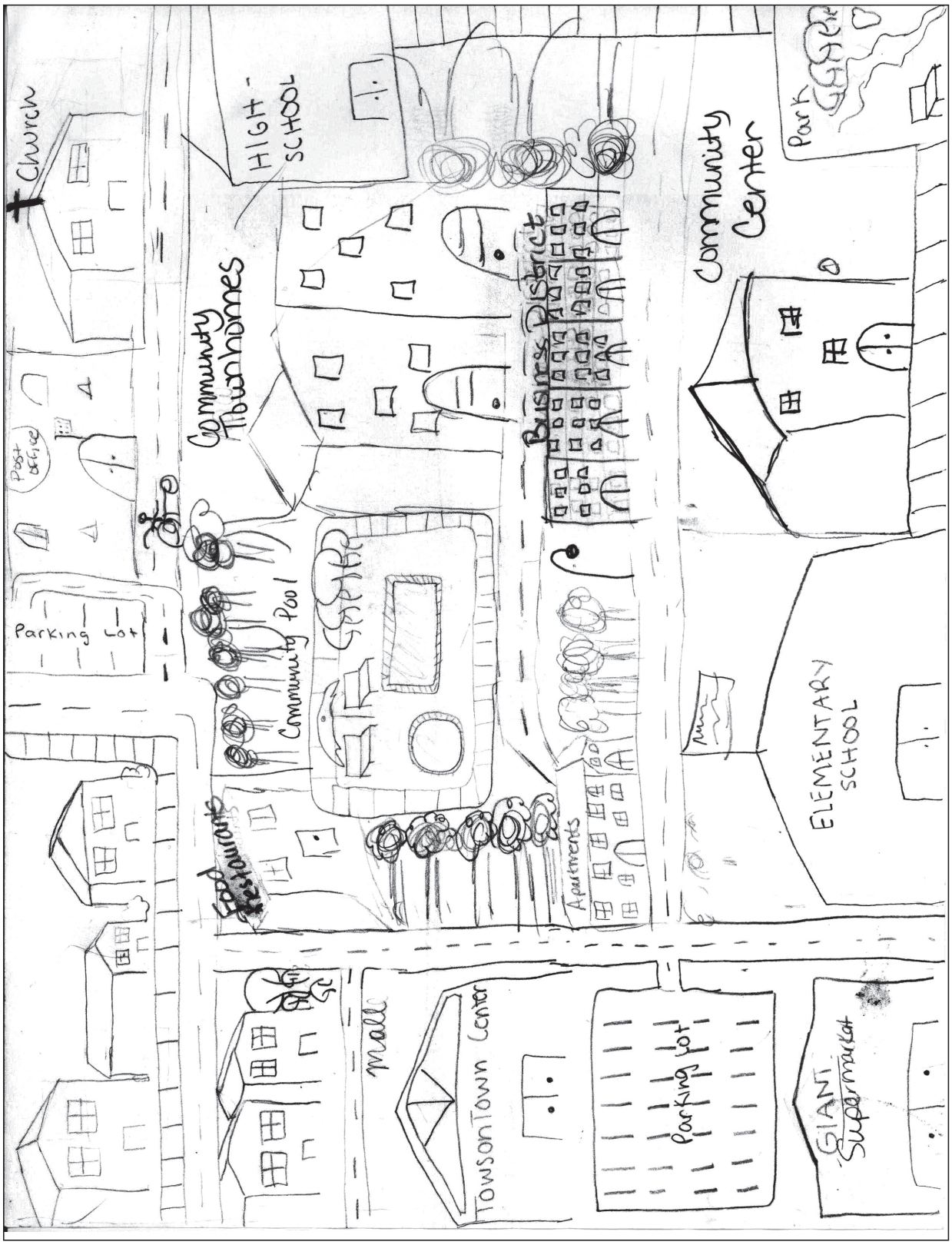
Questions for Research:

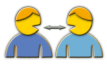
1. What are the characteristics of smart development communities?
2. What are the differences between smart development communities and urban sprawl?
3. What are some environmental benefits of smart development?
4. How does a smart development community affect surface water runoff?
5. What are some health benefits of smart development?

4. Once students have completed their research and written down their findings, distribute several sheets of regular paper, a large sheet of poster paper, art supplies, and a *Smart Development Community Map Organizer* (H 5.3.2) to each group.
5. Ask students to plan their map by completing the organizer and following the instructions on the *Smart Development Community Map Organizer* (H 5.3.2).
6. Tell students that once they have completed the organizer and agreed on an outline, they can start working on their map on the large poster paper. Ask students to put their names in the corner of their poster paper. Explain that they will not finish drawing the map today, but will continue to work on it during Day 2 of the activity.

   Note: An example of a student map is included in these teacher directions for your reference.
7. Collect completed *Smart Development Community Map Organizers* (H 5.3.2) and unfinished poster paper maps. These will be used during Day 2 of the activity.

L 5.3.2.1 Student Map Example



L 5.4 Smart Development Community Design – Day 2 

L 5.4.1 Objectives, Materials, and Teacher Preparation

Objectives

Same as for L 5.3 Smart Development Community Design – Day 1

Materials Needed for Lesson

- Large poster paper with a map drawing that students started working on during Day 1
- Completed *Smart Development Background Research* (H 5.3.1) sheets from Day 1
- *Smart Development Presentation Guide* (H 5.4.1)
- *Smart Development Presentation Feedback Form* (H 5.4.2)
- Markers/crayons/colored pencils

Teacher Preparation

Prepare copies of *Smart Development Presentation Guide* (H 5.4.1). You will need *(number of groups)* x *(number of groups – 1)* copies. Also, prepare copies of *Smart Development Presentation Feedback Form* (H 5.4.2). You will need *((number of students)* x *(number of groups – 1)+(number of groups))* copies. ***Note:*** *(number of students)* x *(number of groups – 1)* copies are for the students evaluating one another's work – each student will evaluate the work of all groups, except his/her own; *(number of groups)* copies are for the teacher evaluating students' work.

L 5.4.2 Activity

Teacher Directions

1. Distribute completed *Smart Development Background Research* (H 5.3.1) sheets and unfinished posters from Day 1.
2. Distribute markers/crayons/colored pencils.
3. Explain to the students that the task today is to finish their maps, and then to present and discuss them with the other groups.
4. Announce how much time is allocated for completing the maps (approximately 30 minutes) and have students work with their groups.
5. Once students have completed their posters, distribute *Smart Development Presentation Guide* (H 5.4.1). Explain that each group will have three minutes to deliver their presentation.
6. Give the groups two to three minutes to choose a speaker and brainstorm the presentation.
7. Give each group a set of *Smart Development Presentation Feedback Forms* (H 5.4.2). The number of the forms in a set should be *(number of students in the group)* x *(number of groups – 1)*. Ask the first group's speaker to deliver the presentation. While the speaker is presenting, the students in the other groups should complete the *Smart Development Presentation Feedback Form* (H 5.4.2).
8. Complete *Smart Development Presentation Feedback Form* (H 5.4.2) for each group.
9. After the presentation, hold a brief (two to three minutes) Q&A discussion session. Use questions from the feedback form to guide the discussion.
10. Give your (the teacher's) feedback form to the group.
11. Repeat steps 7-10 for each remaining group.

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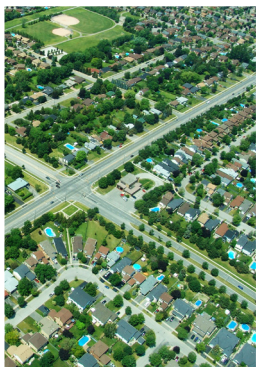
Student Handouts

H 5.1.1 Runoff and Impervious Surfaces Definition Cards

Runoff is water from rain or melted snow that is not absorbed or held by the soil, but runs over the ground and through loose soil.

Impervious surfaces are paved or hardened surfaces that do not allow water to filter through.



Urban sprawl is the increased development of land in suburban and rural areas. It is characterized by single-family homes that are not joined together. These residential areas are also separate from areas where people work and shop, which causes an increase in air pollution, water pollution, and the use of cars.

H 5.1.2 Stormwater Runoff Video Organizer

Name(s): _____ Date: _____

Directions:

While viewing the video, answer the following questions. Be prepared to discuss your answers.

1. **How do impervious surfaces contribute to stream pollution?**

_____

_____

_____

_____

_____

_____

2. **How does runoff affect a stream's habitat?**

_____

_____

_____

_____

_____

_____

3. **How can we reduce pollution from runoff?**

_____

_____

_____

_____

_____

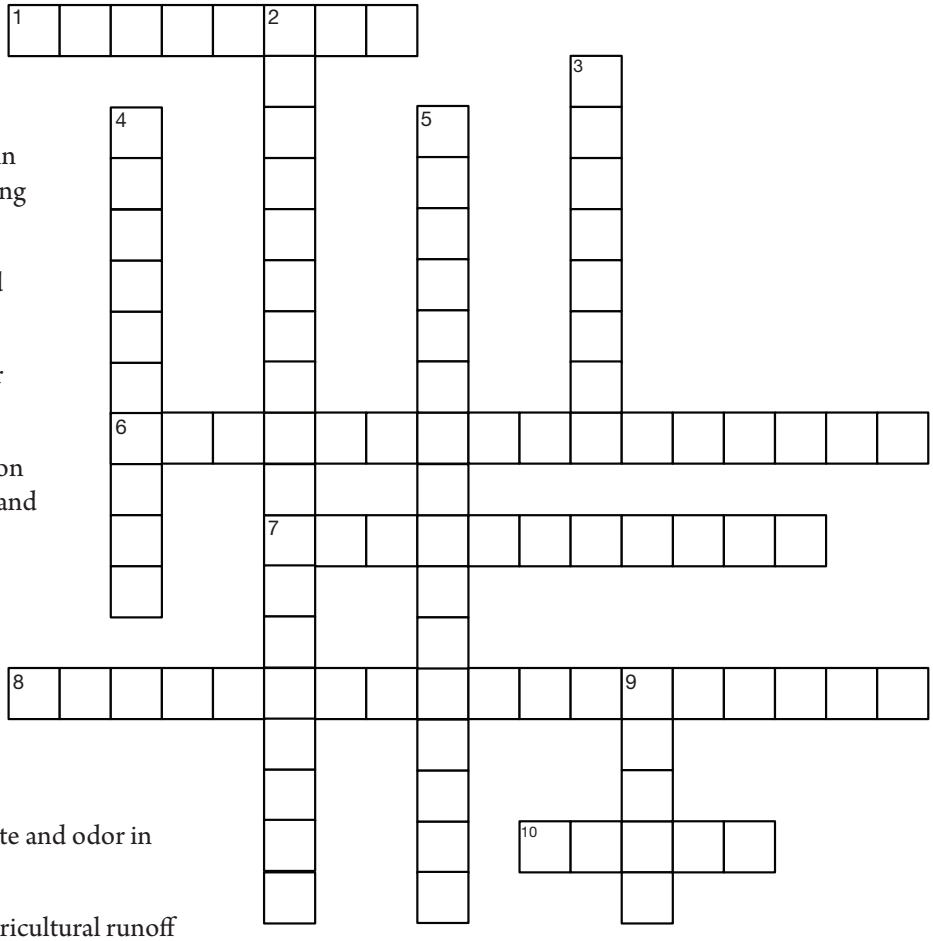
_____

H 5.1.3 Runoff Crossword Puzzle

Name(s): _____ Date: _____

Directions:

Research the Port scene and the Farm scene in Tox Town (toxtown.nlm.nih.gov) to complete the following crossword puzzle about runoff. GOOD LUCK!



Across

1. High levels of nitrates from fertilizers in runoff can cause this syndrome in young infants.*
6. _____ can include dirt and chemicals from construction sites.*
7. Polluted agricultural runoff can trigger _____ in coastal waters.*
8. _____ can include pollution from soil erosion, feeding operations, and animal waste.*
10. Pollution from industrial runoff can include heavy metal, dirt, and salt from _____.

Down

2. _____ can create a bad taste and odor in drinking water.*
3. _____ is found in both agricultural runoff and industrial runoff. It is used as an ingredient in some paint thinners, plastics, and pesticides.
4. This pollutant can be found in our water systems. It is used to kill unwanted pest that cause harm to crops.
5. _____ is one of the leading sources of water pollution in streams, lakes, rivers, and reservoirs.*
9. _____ areas may have concerns with agricultural runoff carrying farm pollutants into waterways.

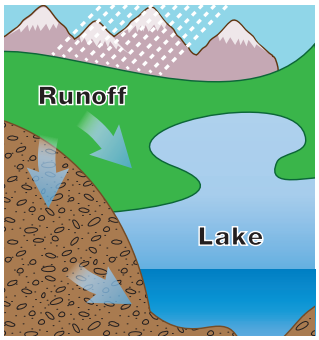
* Two words

H 5.2.1 Impervious Surfaces Lab Instructions

Name(s): _____ Date: _____

During our previous lesson, we learned that stormwater runoff flows over surfaces and transports soil, animal waste, road salts, pesticides, oil, grease, litter, and other pollutants into ponds, lakes, coastal waters, and underground sources of drinking water. The degree of runoff depends on the type of surface over which the water runs.

This lab will investigate how three common surfaces – mulch, grass, and concrete pavement – affect the amount of materials or pollutants that are carried to our bodies of water.



Testable question: What type of surface will absorb the most water in one, three, and five minutes? The least water? Write your answer in the space below:

_____

_____

_____

_____

Variables:

What is the **INDEPENDENT** variable? _____

What is the **DEPENDENT** variable? _____

Materials:

- Graduated cylinder or beaker
- Measuring bottles prepared by teacher
- Water
- Scissors
- *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2)
- Stopwatch
- Plumber's putty (can be purchased in any hardware store)
- Metal spoon

Procedures:

Mulch surface:

1. Pour 20 ml of water into a beaker or a graduated cylinder.
2. Place the bottle on the mulch in upside down position (see picture).
3. Twist the bottle into the mulch so it can stand securely on its own.
4. Pack mulch around the neck of the bottle to make a seal.
5. Pour the water from the beaker of the graduated cylinder into the bottle.
6. Use a stopwatch to record how much water is in the bottle after one, three, and five minutes. Record your observations on the *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2).
7. Collect your materials to re-use them on the next surface.

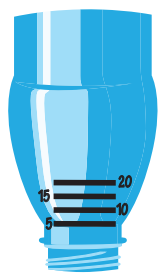
Grass surface:

1. Pour 20 ml of water into a beaker or a graduated cylinder.
2. Use scissors to trim grass to about 0.5 inch. ***Note:*** The roots of the grass are still beneath the surface.
3. Place the bottle into the grass in upside down position (see picture).
4. Twist the bottle in the grass so it can stand securely on its own. Use the spoon to pack dirt around the bottle's neck.
5. Pour the water from the beaker of the graduated cylinder into the bottle.
6. Use a stopwatch to record how much water is in the bottle after one, three, and five minutes. Record your observations on the *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2).
7. Collect your materials to re-use them on the next surface.

Concrete pavement surface:

1. Pour 20 ml of water into a beaker or a graduated cylinder.
2. Place the bottle on the sidewalk in upside down position (see picture).
3. Work putty around the neck of the bottle to make a seal between the bottle and the pavement. Make sure the edge of the seal is very tight so the water cannot seep out of the bottle.
4. Pour the water from the beaker of the graduated cylinder into the bottle.
5. Use a stopwatch to record how much water is in the bottle after one, three, and five minutes. Record your observations on the *Impervious Surfaces Lab Results Recording Sheet* (H 5.2.2).

Measuring bottle, in upside down position



H 5.2.2 Impervious Surfaces Lab Results Recording Sheet

Name(s): _____ Date: _____

Surface	Amount of water left in the bottle after:			Was all the water absorbed? (Y/N)	If "Y," how long did it take?
	1 min. (ml)	3 min. (ml)	5 min. (ml)		
Mulch					
Grass					
Concrete pavement					

1. Which surface absorbed the water the fastest?

_____

_____

2. Which surface absorbed the water the slowest?

_____

_____

3. Were your predictions correct? Explain.

_____

_____

_____

_____

_____

4. Based on your results, what type of land surface helps keep streams and rivers from being polluted? Why?

_____

_____

_____

_____

H 5.2.3 Graph Paper

Name(s): _____ Date: _____

Directions:

Create a line graph of the amount of water absorbed over time by the three surfaces. Remember to include the following: title, axes labels, intervals, scale.

H 5.2.4 Impervious Surfaces Lab Rubric

Name(s): _____ Date: _____

1. Prediction	
Did you make a prediction based on the testable question?	___yes ___ no
Subtotal	**_____/1**

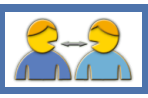
2. Variables	
Did you identify the independent variable?	___yes ___ no
Did you identify the dependent variable?	___yes ___ no
Subtotal	**_____/2**

3. Results	
Did you record your observations in the table?	___yes ___ no
Did you answer the data analysis questions on the results sheet?	___yes ___ no
Subtotal	**_____/2**

4. Graph	
Does your graph have a main title centered at the top?	___yes ___ no
Are your axes labeled?	___yes ___ no
Are your data correctly plotted?	___yes ___ no
Are your line plots marked with names of surface types?	___yes ___ no
Subtotal	**_____/4**

Total	**_____/9**

H 5.3.1 Smart Development Background Research

Name(s): _____ Date: _____

Directions:

Research the following links to gather information about smart development communities and answer the questions below in the space provided. You will use this information later to design your own smart development community.

Link: Smart Growth (Environmental Protection Agency) - epa.gov/dced/topics/index.htm

Link: Designing and Building Healthy Places (Centers for Disease Control and Prevention) - http://www.cdc.gov/healthyplaces/

Link: Urban Sprawl (Tox Town, National Library of Medicine) - toxtown.nlm.nih.gov/text_version/locations.php?id=61

Link: This Is Smart Growth (Smart Growth Network) - smartgrowth.org/pdf/this_is_smart_growth.pdf

1. What are the characteristics of smart development communities?

_____

_____

2. What are the differences between smart development communities and urban sprawl?

_____

_____

3. What are some environmental benefits of smart development?

_____

_____

_____

4. How does a smart development community affect surface water runoff?

_____

_____

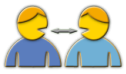
_____

5. What are some health benefits of smart development?

_____

_____

H 5.3.2 Smart Development Community Map Organizer

Name(s): _____ Date: _____

Directions:

Design a map of a smart development community based on the information you researched previously. A sample map is provided in the handout.

1. Decide on the areas/zones that your community will have (e.g., parking, shopping center).
2. For each area/zone, decide on the features/characteristics and enter them into the table below, along with the name of a group member responsible for developing that area/zone.

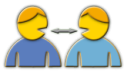
Area/Zone	Features/Characteristics	Group Member's Name
Example: Supermarket	**Example:** Include parking lot, and make sure it is close to homes.	**Example:** John D.

3. Develop the general layout of your community by outlining its locations on a piece of draft paper. Review it with your group. Once you all agree, transfer the layout to the poster paper.
4. Finally, design your map, with each group member completing the drawing for their area(s)/zone(s).

Sample Map


Church
HIGH-SCHOOL
Community Townhomes
Business District
Community Center
Park
Post Office
Parking Lot
Community Pool
Food Restaurants
Apartments
ELEMENTARY SCHOOL
Mall
TowsonTown Center
Parking Lot
GIANT Supermarket

H 5.4.1 Smart Development Presentation Guide



Name(s): _____ Date: _____

Directions:

Be ready to present your community map to others. Your presentation should address the following:

Explain what areas/zones you have in your community.

_____

_____

_____

_____

_____

_____

Explain what makes each of the zones "smart."

_____

_____

_____

_____

_____

_____

Explain how characteristics of your community affect the amount of pollution from surface water runoff.

_____

_____

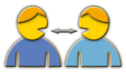
_____

_____

_____

_____

H 5.4.2 Smart Development Presentation Feedback Form



Date:_____

Presenting group members:

_____

_____

_____

_____

_____

Is this community a fun and convenient place to live?	___yes ___ no
Does this community promote healthy living?	___yes ___ no
Is the community easy to get around in?	___yes ___ no
Does the community promote walking?	___yes ___ no
Does the community promote bicycling?	___yes ___ no
Does the community promote using public transportation?	___yes ___ no
Does the community provide job opportunities?	___yes ___ no
Does the community provide business opportunities?	___yes ___ no
Is the community environmentally friendly?	___yes ___ no
Does this community control surface runoff pollution well?	___yes ___ no
Is this community safe?	___yes ___ no

What are some suggestions for improving this community?

_____

_____

_____

_____

_____

_____

Unit 5 Glossary

The following vocabulary is featured in Unit 5 of the Tox Town curriculum.

absorb/absorption rate—Absorb means "to soak up or take in." In terms of environmental science, the term usually applies to the ability of soil to hold or soak up liquid, usually water. Absorption rate is the speed at which a substance (usually land) is able to soak up and hold a liquid (usually water).

chemical—A chemical can be anything that is related to or produced by chemistry. It is something that is manufactured or fabricated.

dependent variable—The dependent variable is the variable that is affected by a manipulation of the independent variable. It is usually the result part of an experiment that is measured and analyzed.

ecosystem—An ecosystem is all of the living and nonliving physical components of a particular area or environment.

environment—Environment refers to the surroundings of something living.

environmental health—Environmental health is the field of science that studies how the environment influences human health and disease. "Environment," in this context, means things in the natural environment like air, water, and soil and also all the physical, chemical, biological, and social features of our surroundings.

impervious surfaces—Impervious surfaces are paved or hardened surfaces that do not allow water to filter through. Roads, rooftops, sidewalks, pools, patios, and parking lots are all impervious surfaces. Impervious surfaces that replace natural, vegetated areas do not allow precipitation to soak into the soil. Instead, water runs off the hardened surfaces and into sewers, local rivers, streams, and large bodies of water.

independent variable—In a lab or science experiment, the independent variable is manipulated to cause a change in something else.

pollute/pollutants—To pollute is to make any part of an environment unfit or harmful to any living thing. A pollutant is anything that pollutes (or causes harm) to the environment.

runoff—Water from rain or melted snow that is not absorbed or held by the soil, but runs over the ground and through loose soil.

saturate/saturation—To saturate is to soak, fill, or load to a substance's capacity. When a substance has reached the point of saturation, it is unable to hold or contain anything else. For example, after days of heavy rains, the ground becomes saturated; it can no longer absorb water.

smart growth—Smart growth is land-use planning theory that promotes an eco-friendly community with development that enhances natural resources and promotes environmental and public health.

toxic—Toxic is a term used to describe the ability of a substance to cause harm to any living organism (plants and/or animals) or the environment.

urban sprawl—Also known as suburban sprawl, urban sprawl is the increased development of land in suburban and rural areas. It is characterized by single-family homes that are not joined together. These residential areas are also separate from areas where people work and shop, which causes increases in air pollution, water pollution, and the use of cars.

variable—A variable is something that is capable of change or being changed. In the scientific process, changing the independent variable should cause a change or an effect on the dependent variable(s).