`

Stormwater Coalition of Monroe County
Stormwater School Curriculum

Developed by
SUNY – Brockport

2011

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Elementary Module

Larry the Fish and Urban Stew

This module is designed to engage students in the causes and implications of unmanaged stormwater runoff and the resulting pollution of our streams and lakes. The approach uses a play script to follow the travels of a fish through different areas of a watershed and talks about the different types of pollution the fish might encounter if people don't participate in reducing stormwater pollution.

The module may meet the following NYS standards.

Physical Setting
Key Idea 2:
Many of the phenomena that we observe on Earth involve interactions among components of air, water, and land.

Performance Indicator 2.1
Describe the relationship among air, water, and land on Earth.

2.1c Water is recycled by natural processes on Earth.
• evaporation: changing of water (liquid) into water vapor (gas)
• condensation: changing of water vapor (gas) into water (liquid)
• precipitation: rain, sleet, snow, hail
• runoff: water flowing on Earth's surface
• groundwater: water that moves downward into the ground

Inquiry and Process Skills

Classifying – arranging or distributing objects, events, or information representing objects or events in classes according to some method or system
Communicating – giving oral and written explanations or graphic representations of observations
Creating models – displaying information, using multisensory representations
Gathering and organizing data – collecting information about objects and events which illustrate a specific situation
Generalizing – drawing general conclusions from particulars
Identifying variables – recognizing the characteristics of objects or factors in events that are constant or change under different conditions
Inferring – drawing a conclusion based on prior experiences
Making decisions – identifying alternatives and choosing a course of action from among the alternatives after basing the judgment for the selection on justifiable reasons
Observing – becoming aware of an object or event by using any of the senses (or extensions of the senses) to identify properties
Predicting – making a forecast of future events or conditions expected to exist

The Living Environment

Key Idea 6:
Plants and animals depend on each other and their physical environment.
Performance Indicator 6.1
Describe how plants and animals, including humans, depend upon each other and the nonliving environment.
6.1f When the environment changes, some plants and animals survive and reproduce, and others die or move to new locations.

Key Idea 7:
Human decisions and activities have had a profound impact on the physical and living environments.
Performance Indicator 7.1
Identify ways in which humans have changed their environment and the effects of those changes.

7.1a Humans depend on their natural and constructed environments.
7.1b Over time humans have changed their environment by cultivating crops and raising animals, creating shelter, using energy, manufacturing goods, developing means of transportation, changing populations, and carrying out other activities.
7.1c Humans, as individuals or communities, change environments in ways that can be either helpful or harmful for themselves and other organisms.

Larry the Fish and Urban Stew

Overview:

This engaging activity gives students a visual understanding of some of the consequences of stormwater pollution.

Levels:

Grades 3-5

Skills:

Observing, Inferring, Communicating, Describing, Writing, Evaluating

Objectives:

Students will: 1) Learn what types of nutrients and toxic substances contribute to stormwater pollution, 2) Better understand the need for clean water, and 3) Determine methods to improve stormwater quality.

Materials:

- Script pages (included)
- Scissors
- Nine index cards
- Glue sticks or tape
- Light colored sponge
- Yarn needle
- Small weight such as a metal nut
- String
- Wide-mouthed jar or beaker
- Cold tap water
- Pencil
- Five small plastic cups or baby food jars
- Soil
- Brown sugar to emulate pet waste
- Vegetable oil to emulate motor oil
- Salt
- Punched paper dots to emulate litter
- Medium beaker or glass jar
- Detergent
- Warm tap water
- Red food coloring to emulate household hazardous waste
- Green food coloring to emulate fertilizer
- Paper and pen or pencil per students

Time Considerations:

45 minutes

Safety Considerations:

Do not dump the contents of the large jar down the sink. Instead, pour the contents through a strainer over a large, grassy area or a compost pile where natural filtration can take place. Throw away the paper dots that have been strained out.

Background:

Stormwater is the water that is produced by rainstorms or snowmelt. When stormwater falls or runs through urban areas, it often washes nutrients and toxic substances from streets, parking lots and lawns into storm drains. The water that enters the storm drains is piped into the nearest stream or river. In most cases, the stormwater never is treated at a sewage treatment facility. The result of polluted stormwater, or "Urban Stew," entering streams, the Genesee River and Lake Ontario is damage to ecosystems. When streams and lakes are polluted, plants, aquatic insects, birds and other animals that depend on themfor survival, suffer.

Ultimately, humans also suffer. Streams and lakes provide urban wilderness areas, and they are used for recreation, agriculture and drinking water. It is only with pollution prevention efforts by local citizens that waterways will remain clean and safe.

Getting Ready:

1. Copy and cut apart the nine roles from the script provided. Attach them with glue or tape to index cards. Laminate them if you choose.

2. Cut the sponge into a fish shape. Using the yarn needle, thread a string through the bottom of the fish. Then, attach the metal nut or small weight so that it hangs below the fish.

3. Fill the large glass jar or beaker 2/3 full with cold water. Thread another string through the top of the fish and suspend it in the water by tying it to a pencil positioned across the mouth of the jar. Adjust the length of the string until the fish is suspended midway in the jar of water.

4. Place the soil in a plastic cup or baby food jar and label it. Put brown sugar in a cup and label it "pet waste"; syrup ("oil") in third cup; salt in a fourth cup; and paper dots ("litter") in cup five. Pour detergent and warm water into the medium sized jar, and set out red and green food coloring – "household hazardous waste" and "fertilizer."

Doing the Activity:

1. Introduce Larry the Fish to the class. Tell them that he has grown up in a protected stream in a nature preserve, but he is about to leave the preserve and journey downstream. The class has been invited to share his adventures. Have the students list several words to describe Larry and the water in the jar.

2. Distribute the script cards, cups, food coloring, and jar of soapy water, to seventeen volunteers. Ask all of the students in the class to number a piece of paper from one to nine. As the students with the script cards read, those with the appropriate ingredients should dump them into Larry's jar on cue. Every student should write down a different descriptive adjective each time that he or

she is asked the question, “How is Larry?”

3. After all of the ingredients have been dumped in the jar, lift Larry out of the jar, and discuss the change is his appearance and that of the water. Ask students to compare their lists of adjectives. Where does stormwater go from Monroe County? Is it treated?

4. Recap with students the sources of the water pollution in the story. Ask the students to brainstorm others specific to their area. Ask the students to list ways in which each form of pollution in the story and those from their list could be prevented.

Extensions:

1. Have students go on a storm drain walk to observe the types of pollution that enters the storm drains in their neighborhoods.

Assessment ideas:

1. Using their adjectives and creativity, ask students to draw cartoons depicting Larry’s adventure, including the sources of pollution he encountered.

2. Give students a little creative license and ask them to devise an educational program to teach others about stormwater pollution and its prevention.

Adapted from *Water, Stones and Fossil Bones*, 1991. Washington, DC: Council for Elementary Science International and National Science Teachers Association.

Larry the Fish and Urban Stew
Script Page

1. Imagine a clean river as it meanders through a protected wilderness area. In this river lives Larry the Fish. **HOW IS LARRY?** Larry has lived in this stretch of the river all of his life. But now he is going on an adventure traveling downstream.

2. Larry swims past a large construction site, where a new mall will be built. There is a lot of loose soil where the land has been leveled. It begins to rain and some of the soil washes into the river. (Dump soil into Larry's jar.) **HOW IS LARRY?**

3. Larry nears a suburban housing development. Some fertilizer from the gardens and lawns washed in to the river a few months back. (Squirt two drops of green food coloring into Larry's jar.) The fertilizer made the plants in the river grow very fast and thick. Eventually the river couldn't furnish them with all the nutrients they needed, so the plants died and started to decay. Their decomposition is using up some of Larry's oxygen. **HOW IS LARRY?**

4. Larry swims under a highway bridge. Some cars traveling across it are leaking oil. The rain is washing the oil into the river below. (Pour syrup into Larry's jar.) **HOW IS LARRY?**

5. During a recent cold spell, ice formed on the bridge. County trucks spread salt on the road to prevent accidents. The rain is now washing salty slush into the river. (Put salt in Larry's jar.) **HOW IS LARRY?**

6. Larry swims past the city park. Some picnickers didn't throw their trash into the garbage can. The wind is blowing it into the river. (Sprinkle paper dots onto Larry's jar.) **HOW IS LARRY?**

7. As Larry nears another neighborhood, he sees bubbles floating in the water. They're soap bubbles coming from a storm drainpipe that runs from the neighborhood to the river. Someone in the neighborhood is washing her car on the street and the soapy water is running into the river. (Pour warm, soapy water into Larry's jar.) **HOW IS LARRY?**

8. Up ahead, a stream joins the river. Larry wants to swim fast through this stretch, because he knows that the stream runs along a trail where people don't clean up after their pets! (Place brown sugar in Larry's jar.) **HOW IS LARRY?**

9. Finally, Larry swims past a trash pile, where people have dumped everything from soda bottles to paint cans. Much of the trash is household hazardous waste that should have gone to the county hazardous waste collection, so it would not pollute the river. (Squeeze three drops of red food coloring into Larry's jar.) **HOW IS LARRY?**

Middle School Modules

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Intermediate Science – Physical Setting

Topography and Watersheds

This module asks students to build a model of a watershed. The ideal situation would have them interpret a local topographic map and build their model to simulate their local area. Once constructed, the model is used to evaluate the flow of water and possible non-point source pollutants over the land surface, then think about ways to minimize runoff pollution. The students could modify their model landscape to test some ideas.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Scientific Inquiry
Key Idea 1:
The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Key Idea 2:
Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Key Idea 3:
The observations made while testing proposed explanations, when analyzed using conventional and invented methods, provide new insights into phenomena.

Standard 6
Systems Thinking
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Models
Key Idea 2:
Models are simplified representations of objects, structures, or systems used in analysis, explanation, interpretation, or design.

Standard 7
Interdisciplinary Problem Solving

Key Idea 1:
The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/ technology/society, consumer decision making, design, and inquiry into phenomena.

General Skills
4. recognize and analyze patterns and trends
8. identify cause-and-effect relationships

Physical Setting Skills
7. generate and interpret field maps including topographic and weather maps

Standard 4 – The Physical Setting

Performance Indicators
2.1i Erosion is the transport of sediment. Gravity is the driving force behind erosion. Gravity can act directly or through agents such as moving water, wind, and glaciers.

2.1j Water circulates through the atmosphere, lithosphere, and hydrosphere in what is known as the water cycle.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Topography and Watersheds

Goal:

Create a physical model of a watershed to observe how water flows across the landscape and analyze the impact of nonpoint source pollution.

Vocabulary:

Area – The amount of space on the surface (2-D)
Volume – The amount of space occupied by an object (3-D)
Google Earth – Is a geographic Information System that shows a 3-D representation of the Earth's Surface that shows spatial and contains attribute data for numerous points.
Surface Runoff – Water that flows over the land as a result of rainfall or snowmelt.
Impervious Surface – An area that water can not easily penetrate and becomes surface runoff.
Imperviousness – The scalar value applied to an impervious surface to describe how much water can penetrate into the ground and how much becomes surface runoff. It is on a scale of 0 – 100.

Need To Know:

No matter where you live, the water quality in rivers and streams is determined by what happens on the land around them. The land around a stream or river is called a watershed. A low rise, a crest of a hill or a mountain chain separates one watershed from another. Rain or snow that falls on opposite sides of the higher land causes water to flow into two different watersheds. One well known example of this is the Continental Divide.

Not all watersheds are the same. Some watersheds are hilly, while other watersheds are flat plains. In all cases, precipitation that falls on the watershed and flows over land will reach the lowest point in the watershed – a lake or river or stream. As water flows over land, it picks up soil, chemicals and other pollutants and carries them to lakes, rivers, or streams or oceans. This water transportation system is called **runoff.**

In rural or agricultural areas, runoff water carries a wide variety of materials, some of which provides nutrients and some of which can be toxic; common materials in runoff include pesticides, soil and animal wastes, which often run directly into waterways. In urban areas, hard surfaces such as driveways, sidewalks, rooftops and roadways prevent water from soaking into the ground. As a result, the runoff water, which can be contaminated with road salt, heavy metals, or automobile fluids, flushes quickly into storm drains that dump directly into streams and rivers. These types of pollutants do not have a single source, so they are called **non-point source pollution.** This pollution originates from many different places. Everyone lives in a watershed. We may not realize that what happens within the watershed may eventually have an impact on the lowest point in the watershed.

NAME: _____

DATE:_____

CLASS:_____

Activity:

1. Begin by reviewing the definition of watershed, and asking yourself about the types of things you might find in a watershed (landforms, plants, animals, homes, etc.). By building a model, you will have the opportunity to observe how water moves through the watershed and the ways in which **runoff** might become polluted.

2. Divide into groups to design your watershed model. Arrange pieces of foam, cardboard or crumpled paper in the bottom of the box to represent hills and landforms. Encourage groups to be creative and include a gully or valley to represent a stream or river. You might want to look at a topographic map of your area to simlulate.

3. Next, cover the landforms with a large piece of aluminum foil, shiny side up. Start with the middle of the box and gently press the foil up into all of the hills and valleys, working towards the box walls. Push the edges of the foil over the edge of the box. Be careful not to tear the foil.

4. With a permanent marker, draw on the foil to outline the stream or rivers in the model. Next, draw houses, roads, farm fields, stores or anything else in their community (refer to the list created earlier).

5. Pour water in a cup with holes in the bottom, or using a small spray bottle, simulate rain on the model. Students should observe how the water moves through the model. Repeat the rain if necessary to make further observations. In what direction does the water flow? What does the path of the water look like (a straight line, curvy, etc.)?

6. Next, ask how the water in the watershed might become polluted. What are the sources for this water pollution? Get some powdered drink mix from your teacher. Have a different color represent a different type of pollutant in their model. For example: use red powder to represent yard care chemicals and sprinkle it near the houses; use green powder to represent salt on the roads or automobile waste and sprinkle it along the roadways or in a parking lot; use blue powder to represent human or animal waste and leave little piles of powder near homes and farms.

7. Sprinkle **small** amounts of the drink mix near the source of the pollution (be careful not to contaminate streams or rivers). Predict what you think will happen when it rains. Record your observations after making rain as in step 5. What happened to the pollution? How has the water changed in the streams and valley? Can you distinguish which source of pollution is causing the problem? When water is polluted by unidentified sources, the pollution is called non-point source pollution.

NAME: _____

DATE:_____

CLASS:_____

Questions

What are examples of non-point source pollution in your watershed?

How can such pollution be prevented?

Can individuals make a difference? How?

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Intermediate Science – Physical Setting

Measuring Surface Runoff

This module is designed to engage students in the determination of the latitude and longitude of a set of given locations and then have them calculate the area of certain man-made objects at those locations in order to calculate rainfall runoff from those impervious areas. The module uses Google Earth to locate objects and calculate areas.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Mathematical Analysis
Key Idea 3:
Critical thinking skills are used in the solution of mathematical problems.

STANDARD 2
Students will access, generate, process, and transfer information, using appropriate technologies.
Key Idea 1:
Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

STANDARD 7
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

General Skills
3. use appropriate units for measured or calculated values

Physcial Setting Skills
1. given the latitude and longitude of a location, indicate its position on a map and determine the latitude and longitude of a given location on a map

Standard 4 – The Physical Setting

Performance Indicators
2.1j Water circulates through the atmosphere, lithosphere, and hydrosphere in what is known as the water cycle.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Measuring Surface Runoff

Goal:

Use Google Earth to calculate areas of impervious surface and determine the amount of runoff from these locations.

Need To Know:

Formulas for area and volume and imperviousness
Basic uses of Google Earth
Basic unit conversion

Area:
Length x Width
Or
Pi x Radius^2

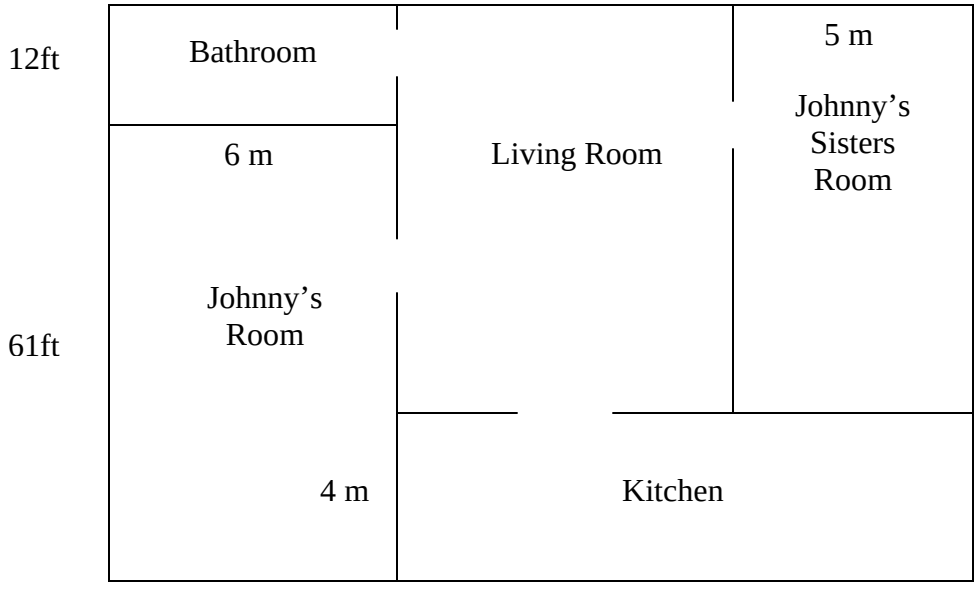
Volume:
Length x Width x Height
or
Area x Height

Useful Conversions:
1 mile (mi) = __5280__ feet (ft)
1 meter (m) = _3.3_ ft
1 Cubic Foot (ft^3) = 7.480519 gallons

Vocabulary:
Area – The amount of space on the surface (2-D)
Volume – The amount of space occupied by an object (3-D)
Google Earth – Is a geographic Information System that shows a 3-D representation of the Earth's Surface that shows spatial and contains attribute data for numerous points.
Surface Runoff – Water that flows over the land as a result of rainfall or snowmelt.
Impervious Surface – An area of the ground surface that water can not penetrate, producing more surface runoff.
Imperviousness – The scalar value applied to an impervious surface to describe how much water can penetrate into the ground and how much becomes surface runoff. It is on a scale of 0 – 100.

Practice Exercises:

1. Johnny's house has five rooms in it. Calculate the square footage of his house using the next page!



NAME: _____

DATE:_____

CLASS:_____

Johnny's House

Use this area to write out your calculations.

Kitchen

Bathroom

Johnny's Room

The Total Area of the House is _____ m^2

If Johnny's house is 8ft tall than what is the total Volume of his house?

_____ m^3

2. Find the Following Locations and write down there Latitude and Longitude Coordinates that appear along the bottom status bar of the screen
   a. The Statue of Liberty, New York City.
      i. Latitude _____ N
      ii. Longitude _____W

   b. The Carrier Dome, Syracuse, NY
      i. Latitude _____ N
      ii. Longitude _____W

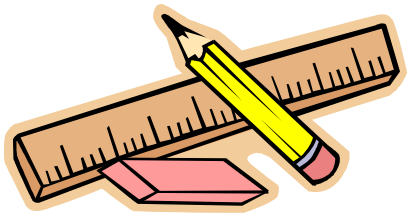
   c. Ontario Beach Park, Rochester, NY
      i. Latitude _____ N
      ii. Longitude _____W

NAME: _____

DATE:_____

CLASS:_____

3. Now Use a different feature of Google Earth
    a. On the top toolbar there is a button that looks like a tape measure. This is the Measure tool. We will be using it to measure various different lengths of objects. You can click as many times that you want and the measure will calculate the total distance traveled along with the last section traveled. Let's get started! (Watch your units!)
    b. Measure the following distances
        i. The distance from Rochester to Buffalo
            1. _____Miles
            2. _____Kilometers



        ii. The width of the Genesee River at its mouth
            1. _____Feet
            2. _____Meters

        iii. The length of Cobb's Hill Reservoir
            1. _____Inches
            2. _____Feet
            3. _____Kilometers

Exercises

Now you will learn how to use Google Earth to calculate the impervious surface created by parking lots and rooftops, both of which are considered impervious surfaces which will cause rainfall to become runoff and flow over the land surface. In order to do this you will use the Measure Tool that you used earlier and think of ways you can properly calculate the area.

1. The Greece Ridge Mall has a large area of rooftops and parking lots, typical of malls throughout the country. Measure the approximate Impervious Surface of the total area of the mall.

    a. Length _____ X Width_____ = _____ft^2

NAME: _____

DATE:_____

CLASS:_____

2. To finish calculating Runoff from an impervious surface you need to calculate the volume of water that would fall in that area. To do this you take the Area you calculated earlier and multiply it by the amount of rain that fell. Lets imagine how much runoff would be produced if 1 inch of rain fell.

    a. Greece Ridge Mall
        i. Area _____ X _____ Rain = _____ ft^3

3. Cubic Feet is a common way in which scientists express the volume of water, but you may not be as familiar with it so convert cubic feet to gallons. To convert the volume from cubic feet to gallons use the conversion:

    a. 1 ft^3 = 7.480519 gallons

    b. Total Volume in Gallons _____

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Intermediate Science – Physical Setting

School Runoff Chemistry

This module has students complete some simple tests on runoff water. The parameters tested might include pH, conductivity and temperature for the first bottle. For the second bottle, the students are looking for an oily sheen to determine the presence of petroleum products and for the sediment that settles to the bottom of the bottle. You can expand question 3 to ask the students to think of ways to reduce the impact. They may want to design plans for their ideas. This would add to the standards covered.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Scientific Inquiry
Key Idea 1:
The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Key Idea 2:
Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Engineering Design
Key Idea 1:
Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop technological solutions to problems within given constraints.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Key Idea 6:
In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs.

STANDARD 7

Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Key Idea 1:

The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/ technology/society, consumer decision making, design, and inquiry into phenomena.

Key Idea 2:

Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

NAME: _____

DATE:_____

CLASS:_____

Exercise: School Runoff Chemistry

Goal:

Analyze the potential impact of surface runoff from manmade surfaces around your school.

Need To Know:

Formulas for area and volume and imperviousness
Basics of pollutant chemistry
Basic unit conversion

Area:
Length x Width
Or
Pi x Radius^2

Volume:
Length x Width x Height
or
Area **x** Height

Useful Conversions:
1 mile (mi) = __5280__ feet (ft)
1 meter (m) = _3.3_ ft
1 Cubic Foot (ft^3) = 7.480519 gallons

Vocabulary:
Area – The amount of space on the surface (2-D)
Volume – The amount of space occupied by an object (3-D)
Surface Runoff – Water that flows over the land as a result of rainfall or snowmelt.
Impervious Surface – An area that water can not easily penetrate and becomes surface runoff.
Nutrients – Elements or compounds that are essential for plant and animal growth. These may also be pollutants if found in excess amounts.
Pollutant – Any element, compound or other materials that may damage the environment into which they are introduced. The concentration of the pollutant is an important factor to consider.

Materials:

Collection bottles
Test kits for parameters such as ammonia, nitrite, nitrate, pH, dissolved oxygen and phosphate
Thermometers
Data sheets

Procedure:

1. Select sites around your school that you think might contribute negative or positive impacts to water quality. The following areas are potential sites you might consider:
    a. Down spouts
    b. Retention basins
    c. Parking lot runoff

2. Wait for a rain storm.

NAME: _____

DATE:_____

CLASS:_____

3. During/After a rain storm, collect samples from the locations that you have decided on in procedure part 1. The most important time to collect samples is during the early part (first 30 minutes) of the storm as runoff begins (first flush).

    a. Special Safety Note: Take all precautions from the danger associated with lightening.
    b. Two samples from each location should be collected (separate bottles)

4. Record information and data on the data collection sheet provided for all weather and collection site conditions.

5. Using water from the first bottle, perform the tests according to the prescribed procedures and record your results

6. The second bottle should be allowed to sit undisturbed. At the end of class make observations, focusing on materials either settled to the bottom of the bottle or floating on the surface of the water.

7. Compare results from the various sampling locations.

8. Make some predictions on environmental impact.

NAME: _____

DATE:_____

CLASS:_____

Data Collection Sheet

Collector's Name(s) _____

Site Location _____

Date _____ Time _____

Wind Direction _____ Wind Speed _____

Time Rain Started_____ Total Rainfall_____

Air Temperature (before the storm) _____ (after the storm) _____

Water Temperature (at time of collection) _____

Water Quality Parameter	Value
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Observations from the second bottle:

NAME: _____

DATE:_____

CLASS:_____

1. Which test site had the highest concentrations of the parameters tested.

2. Why do the parameters you tested vary from site to site.

3. If the runoff from a site drained directly to a pond or stream, predict the possible impacts.

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Intermediate Science – Physical Setting

Analyzing Stormwater Issues

This module asks students to investigate a real problem that might be occurring in their own community or region. The analysis will involve looking at both technical and non-technical aspects of the problem. Once they have completed a guided analysis, they will be asked to present some possible solutions to the problem, giving the pros and cons of their proposal. The focus of the second activity should include qualitative technical, cost and societal aspects.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Engineering Design
Key Idea 1:
Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop technological solutions to problems within given constraints.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Key Idea 6:
In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs.

STANDARD 7
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.
Key Idea 1:
The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/ technology/society, consumer decision making, design, and inquiry into phenomena.

Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including

effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Analyzing Stormwater Issues

Goal:

Solving problems is not always as easy as it seems, and the points of view of many different individuals and groups must be weighed along with the technical feasibility of the putting a potential solution into practice. The goal of this exercise is to evaluate a problem in detail, trying to understand the various aspects that need to be considered before reaching a solution.

Vocabulary:

Problem: A condition in which the status of someone or something is at risk.

Issue: A problem or its solution about which differing beliefs and values exist.

Players: The individuals, groups, or organizations having a role or interest in the issue.

Position: The point of view held by a player concerning the issue.

Solutions: The various strategies available to resolve the issue.

Consequences: The short and long-term by products of one of the proposed solutions.

Need To Know:

Storm water pollution, like other environmental issues, is very complex involving many varied interest groups and several often opposing factors.

Common factors in a given environmental issue might include resource commodity, agency management policies, land-use planning policy, land ownership, weather and climate, local economies, personal behavior, and recent national environmental policy.

Components of Issue Analysis:

An issue's effect and any related action may be local, regional, statewide, national or international. An issue has both short and long-range effects and implications: economically, socially, politically and environmentally. Environmental issues, like many other issues today, rarely have absolute rights and wrongs or cut and dried answers, and generally they are more than two-sided! Any environmental action decision will be a selection of one of several possible alternatives. It may reflect trade-offs or compromises in values of the factors involved and the people and groups affected. Many times, ways are needed to analyze environmental issues in order to better understand them. The following activity provides a logical, problem-solving approach for students to look carefully at many aspects of a situation before coming to any conclusions.

NAME: _____

DATE:_____

CLASS:_____

Activity 1

Answers can be recorded on a separate sheet of paper.

1. Article/Video name, date of publication and publication/organization name.
2 Description of the Issue:
What is happening?
Where is it happening?
Who is affected and how?
What are the impacts of the issue?
3. Rank the impact of the Issue (none, moderate or heavy) locally, regionally and nationally.
4. List some of the Players and their Positions on the Issue. Why might they take this particular perspective?
5. List at least four additional things you want to find out about this issue and how you would collect and record the information.
6. List the major factors you feel are affecting the problem.
7. List at least three possible courses of action to bring about an improvement or solution to the issue.

NAME: _____

DATE:_____

CLASS:_____

Activity 2

1. Suggested course of action (from step 7, activity 1).
2. List positive and negative consequences to selected course of action.
3. Identify individuals, groups, and agencies who can help implement this course of action.
4. Implementation steps (what must be done, what order, when?)
5. How would you evaluate the effectiveness of your actions?

NAME: _____

DATE:_____

CLASS:_____

Guide to Exercise

Part 1 – Issue Analysis

1. Begin by asking the students to distinguish the differences between an environmental problem and an environmental issue. Write the definitions of each so that it is visible for all. Discuss the other components of issue analysis, allowing the students to help define each component.

2. Working in small groups, have students read an article, watch a video, etc, regarding a local water quality issue. The groups should then briefly discuss the article or video and summarize the situation.

3. Distribute activity sheet 1, and have students complete it based on the information gathered in the article or video.

4. When students have completed the activity 1, discuss their findings. What is the main issue are they exploring? Who are some of the key Players? What type of impact will this issue have locally, regionally or nationally? What types of additional information would be helpful? (If time permits, allow students to research additional information.) Review students' suggested solutions.

Part 2 – Alternatives and Action Planning

1. Again in their small groups, students should examine the proposed solutions from step 7, activity 1. Ask the students to brainstorm consequences (both positive and negative) to each alternative.
2. Distribute copies of activity 2. Each group should develop a plan of action for one of their alternatives, keeping the consequences they brainstormed in mind.
3. Have students create a recommendation statement and a presentation for the class, using posters, photos and other materials. Make sure students include how they would evaluate their course of action.

We recommend (this action about the issue)….because (of these facts)…(and these opinions from our group)…The following steps would be necessary to implement our recommendation.

4. Discuss the process with students. What were some of the challenges? Are you surprised by some of the alternatives presented? Did some seem silly at first and now seem more plausible? Could you suggest changes or improvements to any? How could we use this process to resolve other issues?

Adapted from *Analyzing Environmental Issues,* 1996. Champaign, IL: Stipes Publishing.

High School Modules

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Earth Science

Measuring Stormwater Runoff

This module is designed to engage students in the determination of the latitude and longitude of a set of given locations and then have them calculate the area of certain man-made objects at those locations in order to calculate rainfall runoff from those impervious areas. The module uses Google Earth to locate objects and calculate areas.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Mathematical Analysis
Key Idea 3:
Critical thinking skills are used in the solution of mathematical problems.

STANDARD 2
Students will access, generate, process, and transfer information, using appropriate technologies.
Key Idea 1:
Information technology is used to retrieve, process, and communicate information as a tool to enhance learning.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

STANDARD 7
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

Content Area knowledge

STANDARD 4
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1:
Performance Indicator
1.2g Earth has continuously been recycling water since the outgassing of water early in its history. This constant recirculation of water at and near Earth's surface is described by the hydrologic (water) cycle.

- Water is returned from the atmosphere to Earth's surface by precipitation. Water returns to the atmosphere by evaporation or transpiration from plants. A portion of the precipitation becomes runoff over the land or infiltrates into the ground to become stored in the soil or groundwater below the water table.
- Soil capillarity influences these processes.
- The amount of precipitation that seeps into the ground or runs off is influenced by climate, slope of the land, soil, rock type, vegetation, land use, and degree of saturation.
- Porosity, permeability, and water retention affect runoff and infiltration.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Measuring Surface Runoff

Goal:

Use Google Earth to calculate areas of impervious surface and determine the amount of runoff from these locations.

Need To Know:

Formulas for area and volume and imperviousness
Basic uses of Google Earth
Basic unit conversion

Area:
Length x Width
Or
Pi x Radius^2

Volume:
Length x Width x Height
or
Area **x** Height

Vocabulary:

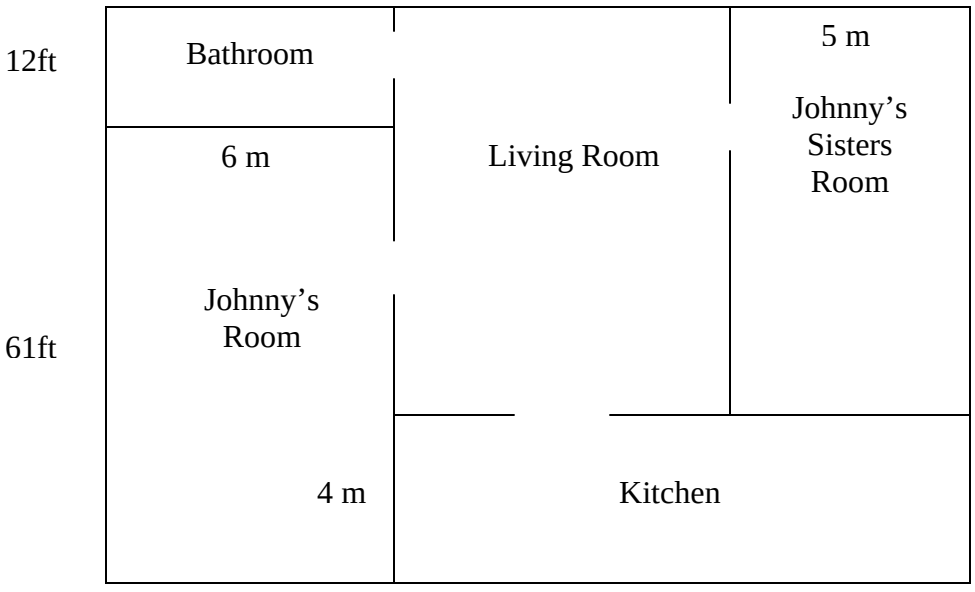
Area – The amount of space on the surface (2-D)
Volume – The amount of space occupied by an object (3-D)
Google Earth – Is a geographic Information System that shows a 3-D representation of the Earth's Surface that shows spatial and contains attribute data for numerous points.
Surface Runoff – Water that flows over the land as a result of rainfall or snowmelt.
Impervious Surface – An area that water can not easily penetrate and becomes surface runoff.
Imperviousness – The scalar value applied to an impervious surface to describe how much water can penetrate into the ground and how much becomes surface runoff. It is on a scale of 0 – 100.

Useful Conversions:

1 mile (mi) = __5280__ feet (ft)
1 meter (m) = _3.3_ ft
1 Cubic Foot (ft^3) = 7.480519 gallons

Practice Exercises:

1. Johnny's house has 4 rooms in it. Calculate the square footage of his house using the next page!



NAME: _____

DATE:_____

CLASS:_____

Johnny's House

Use this area to write out your calculations.

Kitchen

Johnny's Room

Bathroom

Living Room

Johnny's Sisters room

The Total Area of the House is _____ m^2

If Johnny's house is 8ft tall than what is the total Volume of his house?

_____ m^3

Now Lets Practice Using Google Earth!

2. Find the Following Locations and write down there Latitude and Longitude Coordinates that appear along the bottom status bar of the screen
   a. The White House, Washington D.C.
      i. Latitude _____ N
      ii. Longitude _____W

   b. The Golden Gate Bridge in San Francisco, California
      i. Latitude _____ N
      ii. Longitude _____W

   c. Mt. St. Helen, in Washington
      i. Latitude _____ N
      ii. Longitude _____W

NAME: _____

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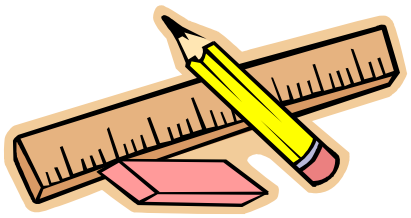
CLASS:_____

d. The farthest point south in the United States (Key West)
   i. Latitude _____ N
   ii. Longitude _____W

3. Now Use a different feature of Google Earth
   a. On the top toolbar there is a button that looks like a tape measure. This is the Measure tool. We will be using it to measure various different lengths of objects. You can click as many times that you want and the measure will calculate the total distance traveled along with the last section traveled. Let's get started! (Watch your units!)
   b. Measure the following distances



      i. The Golden Gate Bridge
         1. _____Miles
         2. _____Kilometers
         3. _____Feet

      ii. From Miami Florida to New York City
         1. _____Nautical miles
         2. _____Miles
         3. _____Meters

      iii. In Washington D.C. Measure from the White House to the Lincoln Memorial
         1. _____Inches
         2. _____Feet
         3. _____Kilometers
      iv. In downtown Miami Beach Florida turn on 'Places of Interest' on your bottom left hand column under 'Layers' by clicking on the check box. Measure the distance from the Alamo Hotel to the nearest beach; remember to stay on the roads/paths!
         1. _____Feet
         2. _____Inches
         3. _____Miles

Exercises

Now you will learn how to use Google Earth to calculate the impervious surface created by parking lots and rooftops, both of which are considered impervious surfaces which will cause rainfall to become runoff and flow over the land surface. In order to do this you will use the Measure Tool that you used earlier and think of ways you can properly calculate the area.

NAME: _____

DATE:_____

CLASS:_____

1. The Cape Canaveral Air Force Station is the longest runway in America in order to land the Space Shuttle. Measure the area of impervious surface of the runway.
    a. Length _____ X Width_____ = _____ft^2

2. The Second Longest runway is at the Columbus Air Force Base in Mississippi. Find and measure the longest runway to calculate the area.

    a. Length _____ X Width_____ = _____ft^2

3. Find the roof area of the Texas Ranger Hall of Fame building in Waco Texas, it has several rooflines. Hint: Divide it up into 5 rooflines
    a. Roof 1: Length _____ X Width _____ = _____ft^2

    b. Roof 2: Length _____ X Width _____ = _____ft^2

    c. Roof 3: Length _____ X Width _____ = _____ft^2

    d. Roof 4: Length _____ X Width _____ = _____ft^2

    e. Roof 5: Length _____ X Width _____ = _____ft^2

    f. Total Roofline _____ft^2

4. Finally measure the roofline of the White House, Washington DC, and calculate the area. Remember there is a half circle, therefore, you will have to use the formula above to do the calculation. This can be done in three sections

    a. Main Roof Line: Length_____ X Width_____=_____m^2

    b. Small Rectangle _____ X Width_____=_____m^2

    c. Semi-Circle (π X (Radius_____ m)^2)/2 = _____m^2

    d. Total Area= _____m^2

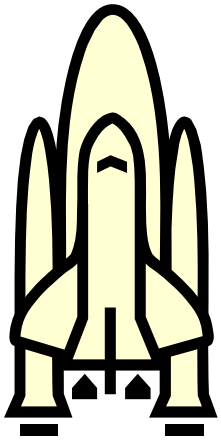
5. To finish up calculating Runoff from an impervious surface you need to calculate the volume of water that would fall in that area. To do this you take the Area you

NAME: _____

DATE:_____

CLASS:_____

calculated earlier and multiply it by the amount of rain that fell. Lets imagine how much runoff would occur if 2.4 inches of rain fell on each of the surfaces you already calculated.



a. Cape Canaveral Runway
    i. Area _____ X _____ Rain = _____ ft^2

b. Columbus Air Force Base
    i. Area _____ X _____ Rain = _____ ft^2

c. Texas Ranger Hall of Fame
    i. Area _____ X _____ Rain = _____ ft^2

d. The White House
    i. Area _____ X _____ Rain = _____ m^2

e. Total Volume in Cubic Feet _____ft^3

6. Calculate the volume in gallons using the conversion:
    a. 1 ft^3 = 7.480519 gallons

    b. Total Volume in Gallons _____

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Earth Science

School Runoff Chemistry

This module has students complete some simple tests on runoff water. The parameters tested might include pH, conductivity and temperature for the first bottle. For the second bottle, the students are looking for an oily sheen to determine the presence of petroleum products and for the sediment that settles to the bottom of the bottle. You can expand question 4 at the end of the module to include the design of retention basin, rain gardens or filter strips for your school that might reduce impact to your local streams.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Scientific Inquiry
Key Idea 1:
The central purpose of scientific inquiry is to develop explanations of natural phenomena in a continuing, creative process.

Key Idea 2:
Beyond the use of reasoning and consensus, scientific inquiry involves the testing of proposed explanations involving the use of conventional techniques and procedures and usually requiring considerable ingenuity.

Engineering Design
Key Idea 1:
Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop technological solutions to problems within given constraints.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

STANDARD 7
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.

Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

NAME: _____

DATE:_____

CLASS:_____

Exercise: School Runoff Chemistry

Goal:

Analyze the potential impact of surface runoff from manmade surfaces around your school.

Need To Know:

Formulas for area and volume and imperviousness
Basics of pollutant chemistry
Basic unit conversion

Area:
Length x Width
Or
Pi x Radius^2

Volume:
Length x Width x Height
or
Area **x** Height

Useful Conversions:
1 mile (mi) = __5280__ feet (ft)
1 meter (m) = _3.3_ ft
1 Cubic Foot (ft^3) = 7.480519 gallons

Vocabulary:
Area – The amount of space on the surface (2-D)
Volume – The amount of space occupied by an object (3-D)
Surface Runoff – Water that flows over the land as a result of rainfall or snowmelt.
Impervious Surface – An area that water can not easily penetrate and becomes surface runoff.
Nutrients – Elements or compounds that are essential for plant and animal growth. These may also be pollutants if found in excess amounts.
Pollutant – Any element, compound or other materials that may damage the environment into which they are introduced. The concentration of the pollutant is an important factor to consider.

Materials:

Collection bottles
Test kits for parameters such as ammonia, nitrite, nitrate, pH, dissolved oxygen and phosphate
Thermometers
Data sheets

Procedure:

1. Select sites around your school that you think might contribute negative or positive impacts to water quality. The following areas are potential sites you might consider:
    a. Down spouts
    b. Retention basins
    c. Parking lot runoff

2. Wait for a rain storm.

NAME: _____

DATE:_____

CLASS:_____

3. During/After a rain storm, collect samples from the locations that you have decided on in procedure part 1. The most important time to collect samples is during the early part (first 30 minutes) of the storm as runoff begins (first flush).

    a. Special Safety Note: Take all precautions from the danger associated with lightening.
    b. Two samples from each location should be collected (separate bottles)

4. Record information and data on the data collection sheet provided for all weather and collection site conditions.

5. Using water from the first bottle, perform the tests according to the prescribed procedures and record your results

6. The second bottle should be allowed to sit undisturbed. At the end of class make observations, focusing on materials either settled to the bottom of the bottle or floating on the surface of the water.

7. Compare results from the various sampling locations.

8. Make some predictions on environmental impact.

NAME: _____

DATE:_____

CLASS:_____

Data Collection Sheet

Collector's Name(s) _____

Site Location _____

Date _____ Time _____

Wind Direction _____ Wind Speed _____

Time Rain Started_____ Total Rainfall_____

Air Temperature (before the storm) _____ (after the storm) _____

Water Temperature (at time of collection) _____

Water Quality Parameter	Value
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____
_____	_____

Observations from the second bottle:

NAME: _____

DATE:_____

CLASS:_____

1. Which test site had the highest concentrations of the parameters tested.

2. Why do the parameters you tested vary from site to site.

3. If the runoff from a site drained directly to a pond or stream, predict the possible impacts.

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Earth Science

Analyzing Stormwater Issues

This module asks students to investigate a real problem that might be occurring in their own community or region. The analysis will involve looking at both technical and non-technical aspects of the problem. Once they have completed a guided analysis, they will be asked to present some possible solutions to the problem, giving the pros and cons of their proposal. The focus of the second activity should include technical, cost and societal aspects.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Engineering Design
Key Idea 1:
Engineering design is an iterative process involving modeling and optimization (finding the best solution within given constraints); this process is used to develop technological solutions to problems within given constraints.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

Key Idea 6:
In order to arrive at the best solution that meets criteria within constraints, it is often necessary to make trade-offs.

STANDARD 7
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.
Key Idea 1:
The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/ technology/society, consumer decision making, design, and inquiry into phenomena.

Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including

effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Analyzing Stormwater Issues

Goal:

Solving problems is not always as easy as it seems, and the points of view of many different individuals and groups must be weighed along with the technical feasibility of the putting a potential solution into practice. The goal of this exercise is to evaluate a problem in detail, trying to understand the various aspects that need to be considered before reaching a solution.

Vocabulary:

Problem: A condition in which the status of someone or something is at risk.

Issue: A problem or its solution about which differing beliefs and values exist.

Players: The individuals, groups, or organizations having a role or interest in the issue.

Position: The point of view held by a player concerning the issue.

Solutions: The various strategies available to resolve the issue.

Consequences: The short and long-term by products of one of the proposed solutions.

Need To Know:

Storm water pollution, like other environmental issues, is very complex involving many varied interest groups and several often opposing factors.

Common factors in a given environmental issue might include resource commodity, agency management policies, land-use planning policy, land ownership, weather and climate, local economies, personal behavior, and recent national environmental policy.

Components of Issue Analysis:

An issue's effect and any related action may be local, regional, statewide, national or international. An issue has both short and long-range effects and implications: economically, socially, politically and environmentally. Environmental issues, like many other issues today, rarely have absolute rights and wrongs or cut and dried answers, and generally they are more than two-sided! Any environmental action decision will be a selection of one of several possible alternatives. It may reflect trade-offs or compromises in values of the factors involved and the people and groups affected. Many times, ways are needed to analyze environmental issues in order to better understand them. The following activity provides a logical, problem-solving approach for students to look carefully at many aspects of a situation before coming to any conclusions.

NAME: _____

DATE:_____

CLASS:_____

Activity 1

Answers can be recorded on a separate sheet of paper.

1. Article/Video name, date of publication and publication/organization name.
2 Description of the Issue:
What is happening?
Where is it happening?
Who is affected and how?
What are the impacts of the issue?
3. Rank the impact of the Issue (none, moderate or heavy) locally, regionally and nationally.
4. List some of the Players and their Positions on the Issue. Why might they take this particular perspective?
5. List at least four additional things you want to find out about this issue and how you would collect and record the information.
6. List the major factors you feel are affecting the problem.
7. List at least three possible courses of action to bring about an improvement or solution to the issue.

NAME: _____

DATE:_____

CLASS:_____

Activity 2

1. Suggested course of action (from step 7, activity 1).
2. List positive and negative consequences to selected course of action.
3. Identify individuals, groups, and agencies who can help implement this course of action.
4. Implementation steps (what must be done, what order, when?)
5. How would you evaluate the effectiveness of your actions?

NAME: _____

DATE:_____

CLASS:_____

Guide to Exercise

Part 1 – Issue Analysis

1. Begin by asking the students to distinguish the differences between an environmental problem and an environmental issue. Write the definitions of each so that it is visible for all. Discuss the other components of issue analysis, allowing the students to help define each component.

2. Working in small groups, have students read an article, watch a video, etc, regarding a local water quality issue. The groups should then briefly discuss the article or video and summarize the situation.

3. Distribute activity sheet 1, and have students complete it based on the information gathered in the article or video.

4. When students have completed the activity 1, discuss their findings. What is the main issue are they exploring? Who are some of the key Players? What type of impact will this issue have locally, regionally or nationally? What types of additional information would be helpful? (If time permits, allow students to research additional information.) Review students' suggested solutions.

Part 2 – Alternatives and Action Planning

1. Again in their small groups, students should examine the proposed solutions from step 7, activity 1. Ask the students to brainstorm consequences (both positive and negative) to each alternative.
2. Distribute copies of activity 2. Each group should develop a plan of action for one of their alternatives, keeping the consequences they brainstormed in mind.
3. Have students create a recommendation statement and a presentation for the class, using posters, photos and other materials. Make sure students include how they would evaluate their course of action.

We recommend (this action about the issue)….because (of these facts)…(and these opinions from our group)…The following steps would be necessary to implement our recommendation.

4. Discuss the process with students. What were some of the challenges? Are you surprised by some of the alternatives presented? Did some seem silly at first and now seem more plausible? Could you suggest changes or improvements to any? How could we use this process to resolve other issues?

Adapted from *Analyzing Environmental Issues,* 1996. Champaign, IL: Stipes Publishing.

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Earth Science

Stream Velocity, Discharge and Runoff

This module looks at the traditional topic of flowing water in streams, but adds a new and important twist by having students investigate the impact of increasing urbanization and the increase in impervious surface that typically accompanies it.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Mathematical Analysis
Key Idea 1:
Abstraction and symbolic representation are used to communicate mathematically.

Key Idea 2:
Deductive and inductive reasoning are used to reach mathematical conclusions.

Key Idea 3:
Critical thinking skills are used in the solution of mathematical problems.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

STANDARD 7
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Key Idea 1:
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Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics,

science, and technology; and presenting results.
Content Area knowledge

STANDARD 4
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1:
Performance Indicator
1.2g Earth has continuously been recycling water since the outgassing of water early in its history. This constant recirculation of water at and near Earth's surface is described by the hydrologic (water) cycle.

- Water is returned from the atmosphere to Earth's surface by precipitation. Water returns to the atmosphere by evaporation or transpiration from plants. A portion of the precipitation becomes runoff over the land or infiltrates into the ground to become stored in the soil or groundwater below the water table.
- Soil capillarity influences these processes.
- The amount of precipitation that seeps into the ground or runs off is influenced by climate, slope of the land, soil, rock type, vegetation, land use, and degree of saturation.
- Porosity, permeability, and water retention affect runoff and infiltration.

2.1u The natural agents of erosion include:

- *Streams (running water):* Gradient, discharge, and channel shape influence a stream's velocity and the erosion and deposition of sediments. Sediments transported by streams tend to become rounded as a result of abrasion. Stream features include V-shaped valleys, deltas, flood plains, and meanders. A watershed is the area drained by a stream and its tributaries.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Stream Velocity, Discharge and Runoff

Goal:

Evaluate and quantify factors that influence the flow of water over the landscape and through the stream system.

Background:

When rain falls on the land, it either seeps into the ground or becomes stormwater runoff, which flows downhill into rivers and lakes, on its journey towards the oceans. Stormwater runoff is water that either does not have time to infiltrate into the ground or rain that falls on an impervious surface.

In natural landscapes the land is not perfectly flat; it slopes downhill in some direction. Flowing water finds its way downhill initially forming small creeks. As small creeks flow downhill they merge to form larger streams and rivers. Rivers eventually end up flowing into the oceans. Stream velocity increases as the volume of the water in the stream increases.

Vocabulary:

Discharge: The amount of water that flows past a given point in a given amount of time.

Drainage divide: The boundary line separating two adjacent drainage basins.

Drainage Basin/ Watershed: The area of land drained by a river system.

Gradient: The ratio of drop in a stream per unit distance. A high gradient indicates a steep slope and rapid flow of water.

Precipitation: Precipitation may be in the form of normal rainfall up to 60 inches per year or excessive rainfall events. Other forms of precipitation include sleet, freezing rain, or light snow

Need To Know:

<u>The velocity of a stream depends on:</u>
Gradient/slope – as slope increases, velocity increases
Discharge (amt. of water)- As the discharge increases, velocity increases.
Channel shape- Streams weather and erode a "V" shaped valley

Average Depth (m) x Width (m) = Cross Sectional Area (m^2)

$$Velocity = \frac{Distance}{Time}$$

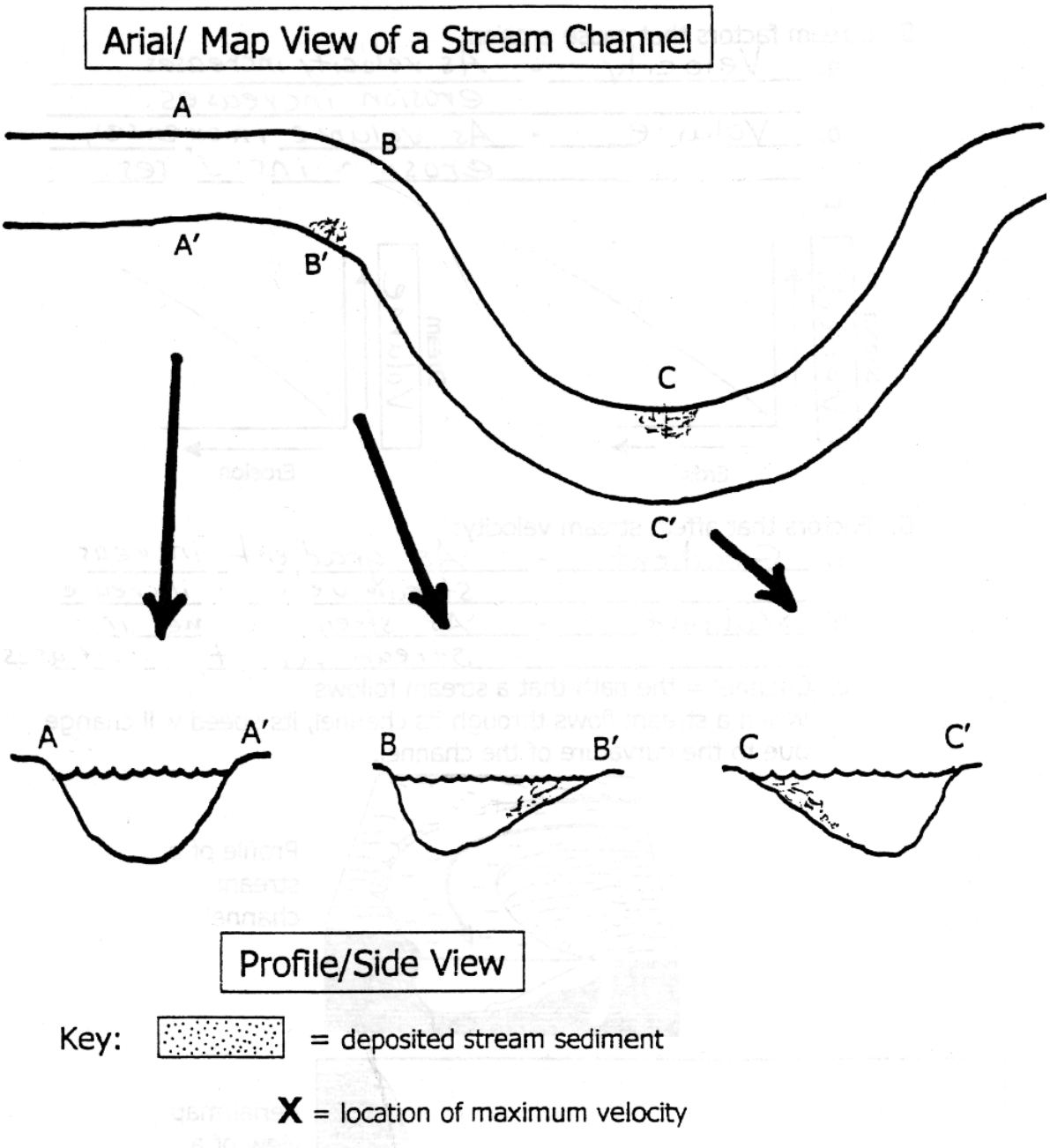
<u>Variation in stream velocity:</u>
- On a straight section of a stream, the fastest speed is just below the surface in the middle (less friction)
- On the outside of a bend or curve the velocity is fastest.
- On the inside of a bend or curve, the velocity is the slowest.

NAME: _____

DATE:_____

CLASS:_____

Part A



NAME: _____

DATE:_____

CLASS:_____

Questions for Part A:

1) Draw an X in the arial view where the stream velocity is the fastest for each profile, and explain your answer.

2) Draw an X in each profile view where the stream velocity is the fastest, and explain your answer.

3) What impact might impervious surfaces have on stream velocity and discharge.

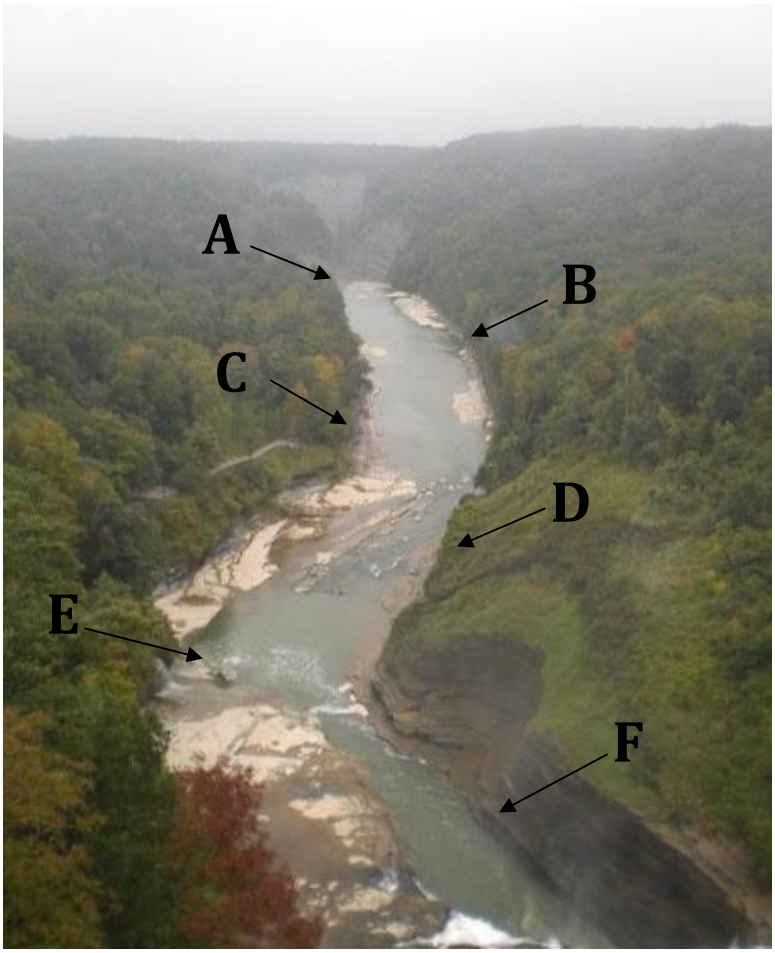
4) How might these impacts be minimized.

NAME: _____

DATE:_____

CLASS:_____

Part B:



Questions for Part B:

1.) Fill in the blanks in the chart using the velocity equation below. Assume that the water is flowing north to south.

Equation:

$$Velocity = \frac{Distance}{Time}$$

NAME: _____

DATE:_____

CLASS:_____

Location	Time (sec)	Distance (feet)	Velocity
A-B	34.2	57	
B-C	44		0.4
C-D		75	0.8
D-E	92.4		1.1
E-F		62	0.8

Stream Discharge

Stream **discharge** is a measure of the volume of water that flows by a certain point in a defined period of time. It is the volume per unit time. Why do we care about a measure such as a stream discharge? The greater the discharge of water, the greater the damage the stream's water can do. During a dry period, the stream may seem small and peaceful, but after a heavy storm, the volume can increase dramatically which causes a faster stream velocity.

Factors affecting the discharge are p**recipitation,** and **permeability of topography**. Precipitation is the primary factor because it is the source of runoff water for streams. After a rainstorm, stream flow follows a predictable pattern where it rises sharply and then falls, usually more gradually, in the hours and days following the storm. **Gradient** is also a key factor. The steeper the gradient (or slope), the faster the water flows. Vegetation slows surface runoff because it naturally absorbs water. It also traps stormwater **runoff**, forcing it to seep into the ground. In cities were vegetation is replaced with parking lots and roads, which do not absorb water, stormwater runoff is greatly increased. This stormwater runoff eventually enters our streams creating greater stream discharge.

Equation:

Discharge = Cross sectional area x velocity

The **cross-sectional area** of the stream is determined by multiplying channel depth by channel width along a transverse section of the stream.

A= (Width * Depth)

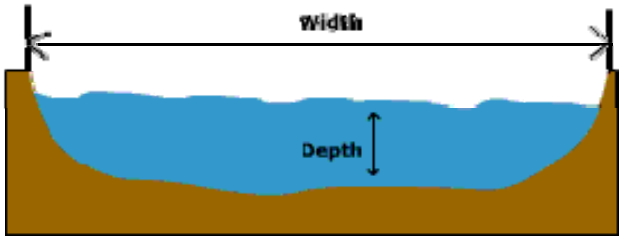
NAME: _____

DATE:_____

CLASS:_____

1.) Calculate the area, velocity or discharge by month for each location using the formula:

Cross section area x mean velocity = Discharge



Month	Area (ft^2)	Velocity (ft/sec)	Discharge (ft^3/sec)
January	2365	0.14	
Feb	2377		261.47
March		0.34	909.5
April	2031		1238.9
May	2145	1.4	3003
June		0.87	2337.7
July	2543		1856.4
August	2189	0.64	1401
Sept	2005		1102.8
October	2976	0.32	
November		0.33	776.5
December	2201	0.12	264.1

On one sheet of graph paper create a line graph of the month versus discharge.

Questions:

NAME: _____

DATE:_____

CLASS:_____

1) What month had the highest discharge? Why do you think this is?

2) What month had the lowest discharge? Why do you think this is?

3) If the velocity of the stream increased during January, how would the discharge be affected?

4) What do you think would account for an increase in discharge?

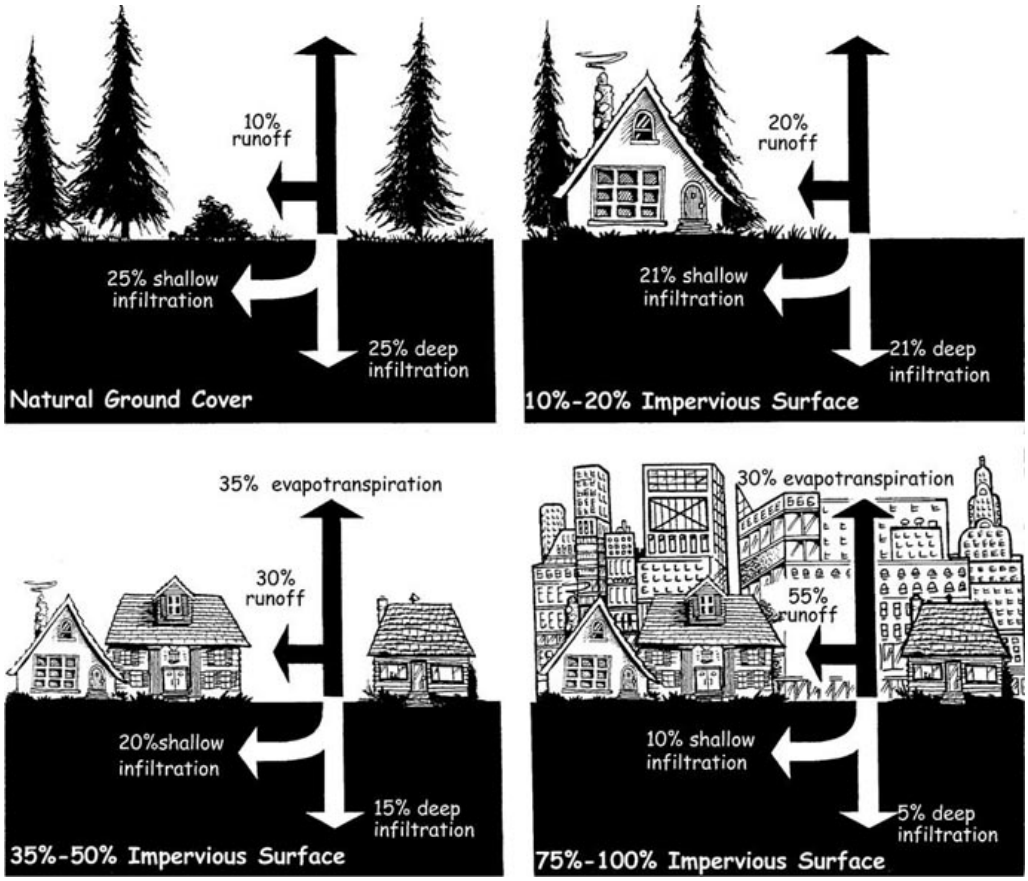
5) What would account for a decrease in discharge?

NAME: _____

DATE:_____

CLASS:_____

Part C.



Using the diagram above make a rough graph of how runoff changes with impervious surface.

NAME: _____

DATE:_____

CLASS:_____

Questions

1) How does development change the stream discharge during a storm event?

2) How does the removal of vegetation impact stream velocity?

3) How would the water quality of an area with 100% of impervious surfaces compare with an area of only 20%?

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Earth Science

Impacts to Water Quality

The module looks at the impact of stormwater runoff on the dissolved and suspended load of streams. It uses a simple model of mixing to evaluate the impact of untreated storm sewer discharge into a local stream. Finally it asks students to apply their knowledge by designing a public awareness campaign that educates people on common pollutants around the home and ways to prevent pollution. The module could be expanded by collecting and analyzing stream and storm sewer discharge in a way similar to those described in the Runoff Chemistry module, and by asking them to design systems a system to minimize impact. This would add to the list of standards met.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Mathematical Analysis
Key Idea 1:
Abstraction and symbolic representation are used to communicate mathematically.

Key Idea 2:
Deductive and inductive reasoning are used to reach mathematical conclusions.

Key Idea 3:
Critical thinking skills are used in the solution of mathematical problems.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

STANDARD 7
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.
Key Idea 1:
The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/ technology/society, consumer decision making, design, and inquiry into phenomena.

Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics, science, and technology; and presenting results.

Content Area knowledge

STANDARD 4
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 1:
Performance Indicator
1.2g Earth has continuously been recycling water since the outgassing of water early in its history. This constant recirculation of water at and near Earth's surface is described by the hydrologic (water) cycle.

- Water is returned from the atmosphere to Earth's surface by precipitation. Water returns to the atmosphere by evaporation or transpiration from plants. A portion of the precipitation becomes runoff over the land or infiltrates into the ground to become stored in the soil or groundwater below the water table.
- Soil capillarity influences these processes.
- The amount of precipitation that seeps into the ground or runs off is influenced by climate, slope of the land, soil, rock type, vegetation, land use, and degree of saturation.
- Porosity, permeability, and water retention affect runoff and infiltration.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Impacts to Water Quality

Goal:

Evaluate the impact to water quality of pollutants washed off the ground surface by stormwater runoff.

Vocabulary:

Stream system- the watershed or drainage basin.
Tributary- A smaller stream that flows into a large one.
Runoff- Water that either does not have time to sink into the ground or is produced in such quantity (e.g., floods) that the normal soaking up process cannot take place.
Impervious surface- Surface that does not let water easily flow through it. (Paved parking lots)
Pervious surface- Surface that allows water to easily pass through it (infiltrate). (Grass)
Concentration- the strength of a solution
Pollutants – unwanted chemicals or other materials found in the water i.e. pesticides, fertilizers, oil, gas, sewage, anti freeze, pet waste, chemical waste, household cleaners, chlorine, herbicides and also ROAD SALT

Background:

Why should people be concerned about what enters a storm drain? Because anything that flows down a storm drain is not "treated," and it does not go to the local wastewater treatment facility before it reaches a stream or one of the Great Lakes in our area. This means that oil, antifreeze, paint, grass clippings, household waste, pet wastes, or any other waste on streets and sidewalks go directly into the nearby waterways. Even the road salt put on roads during the winter adds to the contamination of water. This can be detrimental to plants, animals, and humans as the water quality degrades.

Community members should also be aware of storm water pollution because the U.S. Government regulates runoff that enters surface water through storm drains. You can help increase awareness of the storm drain connection. By educating the local community and your peers through flyers, posters, door hangers, stenciling, and other efforts, you can help improve and protect the water quality of the Great Lakes. Pollution prevention is less costly than alternative treatment methods.

Need To Know:

$$\text{Concentration} = \frac{\text{Mass}}{\text{Volume}} \qquad \text{example units mg/L}$$

$$\text{Discharge} = \frac{\text{Volume}}{\text{Time}} \qquad \text{example units L/sec}$$

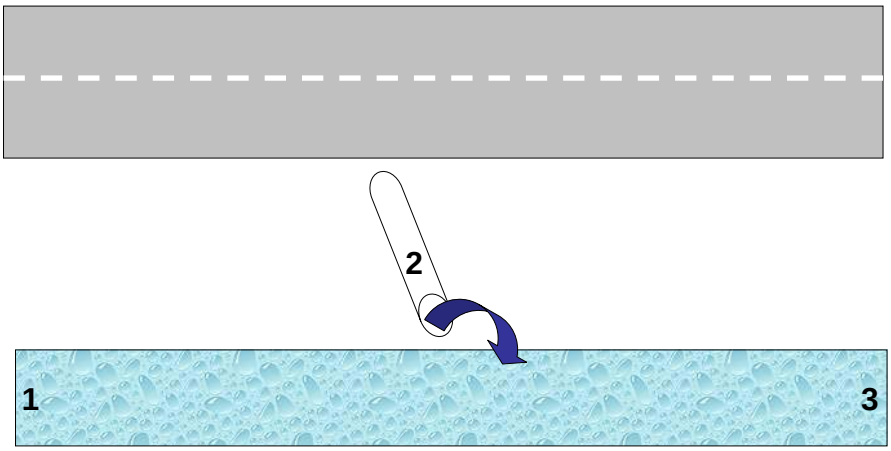
Load = Concentration x Discharge

NAME: _____

DATE:_____

CLASS:_____

Part A:



Questions:

1.) The flow of the water in this stream is from left to right. The water in the stream at Location 1 is clean and free of pollutants. Notice how the runoff containing the road salt enters the stream at Location 2. Do you think that the concentration at Location 3 will be lower or higher than at Location 1. Explain your answer.

2.) If the discharge at Location 1 is 100 L/sec, and the discharge at Location 3 is 247 L/sec, what is the discharge at Location 2? Assume no other inputs to the stream. Show your work.

NAME: _____

DATE:_____

CLASS:_____

3.) Given the following information and the discharge information from number 2, calculate the load at location 1 and 2. Show your work.

Chloride concentration from road salt

Location 1 = 50 mg/L

Location 2 = 400 mg/L

4) Load is cumulative. Therefore, calculate the load at location 3 by summing the loads for locations 1 and 3.

5) Now calculate the chloride concentration at location 3. Is it higher or lower than location 1, why.

NAME: _____

DATE:_____

CLASS:_____

6) What would happen to the concentration of road salt at Location 3 if the amount of discharge at Location 2 increased due to a snow melt? Assume the concentration is the same. Explain your answer.

5.) List two potential pollutants at your home and how you would prevent them from entering storm drains.

NAME: _____

DATE:_____

CLASS:_____

Part B

Group Activity:

We have just learned in the previous activity that it is very important to prevent pollutants from entering our waterways. Educating the public is the first step to improving the quality of local water. In small groups, design a poster, video, or gimmick to promote stormwater pollution awareness. Another possibility is designing a drainage stencil to spray on local drains in your community.

Be sure to highlight

* The target audience to whom you would display your public awareness project
* At least 4 common stormwater pollutants in your community
* 4 ways to prevent stormwater pollution
* Innovative slogan
* Colorful

References:

Salt Lake County Storm Water Quality Education Lesson and Activity Plans
3rd Edition - December 2005

Stormwater Curriculum
Teachers Guide to NYS Curriculum Standards
Earth Science

Stormwater Management

This module puts into practice much of what students have learned about stormwater and about the erosive capacity of runoff. The results of the service learning project may be used by the school as part of a green initiative to improve environmental quality.

The module meets the following NYS standards.

Process Skills based on Standards 1, 2, 6 and 7.

STANDARD 1
Mathematical Analysis
Key Idea 1:
Abstraction and symbolic representation are used to communicate mathematically.

Key Idea 2:
Deductive and inductive reasoning are used to reach mathematical conclusions.

Key Idea 3:
Critical thinking skills are used in the solution of mathematical problems.

STANDARD 6
Students will understand the relationships and common themes that connect mathematics, science, and technology and apply the themes to these and other areas of learning.
Key Idea 1:
Through systems thinking, people can recognize the commonalities that exist among all systems and how parts of a system interrelate and combine to perform specific functions.

STANDARD 7
Students will apply the knowledge and thinking skills of mathematics, science, and technology to address real-life problems and make informed decisions.
Key Idea 1:
The knowledge and skills of mathematics, science, and technology are used together to make informed decisions and solve problems, especially those relating to issues of science/ technology/society, consumer decision making, design, and inquiry into phenomena.

Key Idea 2:
Solving interdisciplinary problems involves a variety of skills and strategies, including effective work habits; gathering and processing information; generating and analyzing ideas; realizing ideas; making connections among the common themes of mathematics,

science, and technology; and presenting results.

Content Area knowledge

STANDARD 4
Students will understand and apply scientific concepts, principles, and theories pertaining to the physical setting and living environment and recognize the historical development of ideas in science.

Key Idea 2:
Performance Indicator
2.1t Natural agents of erosion, generally driven by gravity, remove, transport, and deposit weathered rock particles. Each agent of erosion produces distinctive changes in the material that it transports and creates characteristic surface features and landscapes. In certain erosional situations, loss of property, personal injury, and loss of life can be reduced by effective emergency preparedness.

NAME: _____

DATE:_____

CLASS:_____

Exercise: Stormwater Management

Goal:

This exercise provides an opportunity to put into practice your knowledge of stormwater runoff in the context of preserving the environment.

Need To Know:

The National Pollutant Discharge Elimination System (NPDES) Stormwater Program regulates stormwater discharges from three potential sources: municipal separate storm sewer systems (MS4s), construction activities, and industrial activities. Most stormwater discharges are considered point sources, and operators of these sources may be required to receive an NPDES permit before they can discharge. This permitting mechanism is designed to prevent stormwater runoff from washing harmful pollutants into local surface waters such as streams, rivers, lakes or coastal waters.

Vocabulary:

MS4 – Municipal separate stormsewer system. The system of sewers and drainage ditches that collect and transport stormwater runoff.
Construction Activities – Any related activity that disturbs more than 1 acre of land.
Point Source – Stormwater discharge that enters a waterbody at a single point such as a pipe.
Non-Point Source – Stormwater runoff that flows overland and enters a waterbody at other than a single point.
Surface Runoff – Water that flows over the land as a result of rainfall or snowmelt.
Impervious Surface – An area that water can not easily penetrate and becomes surface runoff.

- Phase I, issued in 1990, requires *medium* and *large* cities or certain counties with populations of 100,000 or more to obtain NPDES permit coverage for their stormwater discharges.
- Phase II, issued in 1999, requires regulated small MS4s in urbanized areas, as well as small MS4s outside the urbanized areas that are designated by the permitting authority, to obtain NPDES permit coverage for their stormwater discharges.

NAME: _____

DATE:_____

CLASS:_____

Erosion Control

Background:

Soil is important to us. We farm the land to provide food for millions of people. We clear and level land to build homes, factories and shopping centers. Every year, large amounts of soil are exposed to wind and rain and carried away. This process is called **erosion**.

Erosion occurs when soil and rocks are washed into streams and rivers, causing a muddy buildup on the bottom of the waterway. This extra mud changes fish and wildlife habitat, and can restrict water flow.

There are two major approaches to controlling erosion. The first approach, perimeter control, uses sediment basins and traps, straw bales and silt fences to capture sediment along the edge– or perimeter – of the site. Perimeter controls can stop 30-85% of eroded soils from leaving the site.

The second approach, stabilization, relies on some kind of ground cover to stop erosion before it begins or to prevent any further soil loss. This approach involves covering the bare earth with mulch, erosion control fabric (most often laced with grass seed) mats or vegetation. Stabilization reduces soil loss by up to 95%.

What would happen without erosion controls? Runoff from a construction site may flow into the **storm drain system**, leading directly into nearby streams and rivers. While soil from stream and riverbanks is always eroding somewhat, excessive erosion can be problematic. Increased soil and rock material in waterways can be detrimental to fish and wildlife habitat, as well as to overall water quality.

NAME: _____

DATE:_____

CLASS:_____

Activities

1. Begin by taking students on an erosion walk either on the school grounds or in the surrounding areas. Have students try to identify 3-4 examples of erosion and, if possible, locations were erosion control methods are being implemented and materials being used. What are the signs of erosion? Where and why is it important to control and prevent erosion? How might further erosion be prevented or controlled? Are there places where erosion should not or cannot be controlled?

If possible, have students compare and contrast a site where erosion is obvious with one in which it is not. Try to return to the sites when it's raining or right after the rain. What differences and similarities do they notice?

2. Have students research community issues regarding soil erosion, prevention and policies. Some of the following methods may be helpful in gathering information:

- Contact your town of village department of public works.
- Have a building contractor visit and discuss the methods and regulations around erosion control.
- Contact the Soil and Water Conservation District to learn more about erosion control methods.

3. Have students make an experimental erosion control plan. Using the information they have gathered, as well as their observations and creativity, have students design other erosion control methods. When thinking about the plan, consider the following questions:

- How effective are current methods such as straw bale fences, silt fences, or sediment basins?
- What would be the best way to control erosion during winter or spring melt?
- What would be the best way to control erosion on very steep slopes?
- What is the lowest cost erosion control method?
- Which erosion control method requires the least maintenance?
- Think of a novel approach to erosion control, one that is low cost, easily maintained and will last a long time.

AP Stormwater Lesson Plan

Analyzing Storm Water Issues

Overview:

Through the process of analyzing environmental issues, students learn about the many participants and perspectives involved, and gain insight on the challenges to developing solutions. They also recognize the range of skills needed to analyze complex environmental problems.

Skills:

Researching, Analyzing, Comparing, Summarizing, Interpreting.

Objectives:

Students will: 1) Identify, collect and analyze data about a storm water issue, 2) Identify and list individuals and/or groups who might be interested in or affected by a storm water issue, 3) Identify factors contributing to an issue, 4) Generate possible courses of action to solve problems, and evaluate the advantages and disadvantages of these actions, 5) Select a proposed solution, recommendation, or course of action, and determine its feasibility and plan its implementation, 6) Prepare a presentation to forward their group's plan.

Materials:

- Copies of activity sheets 1 and 2 for each student (at the end of the lesson plan)
- Current information sources such as newspapers and magazines, state and federal agency reports, videos, etc.; Internet access is optional
- Butcher paper
- Markers and pens
- Tape
- Camera and Film (optional)
- Overhead transparency sheets (optional)
- Other materials for presentations

Time Considerations:

Time considerations depend on the depth and breadth of the research methods, presentations, etc.

Setting/Group size:

Classroom/ 3-4 students per group or entire class.

Background:

Stormwater pollution, like other environmental issues, is very complex involving many varied, and at times opposing, constituencies. Common factors in a given environmental issue might include resource commodity, agency management policies, land-use planning policy, land ownership, weather and climate, local economies, personal behavior, and recent national environmental policy.

A given issue's effect and any related action may be local, regional, statewide, national or international. An issue has both short and long-range effects and implications: economically, socially, politically and environmentally. Environmental issues, like many other issues today, rarely have absolute rights and wrongs or cut and dried answers, and generally they are more than two-sided. Any environmental action decision will be a selection of one of several possible alternatives. It may reflect trade-offs or compromises in values of the factors involved and the people and groups affected. Many times, ways are needed to analyze environmental issues in order to better understand them. The following activity provides a logical, problem-solving approach for students to look carefully at many aspects of a situation before coming to any conclusions.

Components of Issue Analysis

Problem: A condition in which the status of someone or something is at risk.
Issue: A problem or its solution about which differing beliefs and values exist.
Players: The individuals, groups, or organizations having a role or interest in the issue.
Position: The point of view held by a player concerning the issue.
Solutions: The various strategies available to resolve the issue.
Consequences: The short and long-term by products of one of the proposed solutions.

Getting Ready:

1. Make copies of activity sheets 1 and 2, one per student.

2. A few weeks in advance, have students begin collecting (or do so yourself) resource materials such as newspaper and magazine articles, brochures, etc., regarding local water quality issues.

3. Prior to working with students, you might want to do the activity yourself using an article from the local newspaper.

Doing the Activity:

Part 1 – Issue Analysis

1. Begin by asking the students to distinguish the differences between an environmental problem and an environmental issue. Write the definitions of each so that it is visible for all. Discuss the other components of issue analysis, allowing the students to help define each component.

2. Working in small groups, have students read an article, watch a video, etc, regarding a local water quality issue. The groups should then briefly discuss the article or video and summarize the situation.

3. Distribute activity sheet 1, and have students complete it based on the information gathered in the article or video.

4. When students have completed the activity 1, discuss their findings. What is the main issue are they exploring? Who are some of the key Players? What type of impact will this issue have locally, regionally or nationally? What types of additional information would be helpful? (If time permits, allow students to research additional information). Review students' suggested solutions.

Note: www.h20hero.org may be a useful resource to find information on various issues

Part 2 – Alternatives and Action Planning

1. Again in their small groups, students should examine the proposed solutions from step 7, activity 1. Ask the students to brainstorm consequences (both positive and negative) to each alternative.

2. Distribute copies of activity 2. Each group should develop a plan of action for one of their alternatives, keeping the consequences they brainstormed in mind.

3. Have students create a recommendation statement and a presentation for the class, using posters, photos and other materials. Make sure students include how they would evaluate their course of action.

   We recommend (this action about the issue)….because (of these facts)…(and these opinions from our group)…The following steps would be necessary to implement our recommendation.

4. Discuss the process with students. What were some of the challenges? Are you surprised by some of the alternatives presented? Did some seem unreasonable at first and now seem more plausible? Could you suggest changes or improvements to any? How could we use this process to resolve other issues?

Extensions:

1. Have students write several paragraphs from the prospective of one of the issue's Players. Then compare and contrast it with their own perspectives about the issue.

2. Have students role-play the issue in the context of a public hearing, TV debate, radio show or panel discussion.

3. Have students write or produce a public service announcement for the school newspaper.

Assessment ideas:

1. Have students find their own article, video, brochure, etc., regarding water quality and analyze the issues presented.

Adapted from *Analyzing Environmental Issues*, 1996. Champaign, IL: Stipes Publishing.

Activity 1

1. Article/Video name, date of publication and publication/organization name.

2. Description of the Issue:
   What is happening?
   Where is it happening?
   Who is affected and how?
   What are the impacts of the issue?

3. Rank the impact of the Issue (none, moderate or heavy) locally, regionally and nationally.

4. List some of the Players and their Positions on the Issue. Why might they take this particular perspective?

5. List at least four additional things you want to find out about this issue and how you would collect and record the information.

6. List the major factors you feel are affecting the problem.

7. List at least three possible courses of action to bring about an improvement or solution to the issue.

Activity 2

1. Suggested course of action (from step 7, activity 1).

2. List positive and negative consequences to selected course of action.

3. Identify individuals, groups, and agencies who can help implement this course of action.

4. Implementation steps (what must be done, what order, when?).

5. How would you evaluate the effectiveness of your actions?

Fed Up

Overview:
Through a controlled experiment, students will compare the effects of varying nutrient levels on water and discuss the process of eutrophication in aquatic environments, and the potential human sources that impact stormwater runoff.

Skills:
Analyzing, Applying, Comparing, Discussing, Measuring, Observing

Objectives:
Students will:

1) Perform a controlled experiment examining the changes in pond water due to phosphate and nitrate enrichment over a 30-day period

2) Explain what eutrophication is and how excessive nutrients affect water quality

3) Explain the role of phosphorus and nitrogen compounds in the eutrophication of water systems

4) Identify nonpoint sources of nutrient enrichment that impact stormwater runoff.

5.) Research and identify Best Management Practices (BMPs) used by local farmers and homeowners to develop new recommendations and methods to prevent eutrophication.

Materials:

- Granulated fertilizer of equal nitrate and phosphate concentration
- Pond or stream water, enough to fill three 1-quart jars per group
- Three 1-quart jars per group
- Safety goggles
- Several 1tsp.measuring spoons (minimum 1)
- Hand lenses
- Student Data sheets (included), 3 per group
- Masking tape or labels
- Water-resistant marking pens
- Paper towels
- Dissolved oxygen test kit (optional)
- Sun lamp or grow light (optional)
- Camera and film (optional)
- Compound microscopes and commercially prepared algae slides (optional)

• Algae identification books (optional)

Time Considerations:

One class period to set-up the experiment; 10-minute observations for 30 days; One class period for experiment conclusions and wrap-up

Setting/Group size:

Classroom/ 3-4 per group

Safety Considerations:

Students should wear safety goggles while handling chemicals and wash hands when finished. Nitrates and phosphates can stain clothing and skin. At completion of experiment, dispose of algae samples by dumping each jar on the school lawn, making sure to disperse samples in several areas.

Background:

The population of aerobic (oxygen-dependant) life in a pond, lake or stream depends in part on the amount of dissolved nutrients in the water. Too little or too much of any single nutrient can limit or prevent growth of a population of plants or animals, even if the other factors within the ecosystem are at or near their most desirable range. Nutrients like phosphates and nitrates stimulate plant growth and are **limiting factors** in the growth of plant life. In other words, they naturally occur in limited amounts that help govern the growth of different organisms and keep ecosystems in balance. Water low in nutrient is called **oligotrophic,** while water high in nutrients is call **eutrophic**. Phosphorous is usually the least available or limiting nutrient in freshwater ecosystems followed by nitrogen. In salt-water ecosystems, nitrogen is the limiting nutrient. **Eutrophication** is a natural and gradual process of nutrient enrichment in waterways. The nutrients encourage plant growth and eventually lakes and other water bodies accumulate decaying plant materials and begin to shrink in size, often becoming a bog or marsh. Eutrophication typically happens slowly over millions of years. When the process of eutrophication is accelerated by the addition of excess nutrients it can cause great damage. Excess nutrients may come from a variety of sources, many of which are dispersed throughout the landscape and referred to as non-point sources. These non-point sources contribute excess nutrients to stormwater runoff if not managed properly. When excess amounts of phosphates and nitrates are introduced into a waterway via stormwater runoff, some plant species can experience explosive growth, literally out-competing other life forms. One such example is the rapid growth of blue-green or other algae. This is called an **algal bloom.** Algal blooms can produce thick surface mats, turn water green, stain boats, cause skin rash on swimmers, and may be toxic to animals that drink the water. When the excess nutrients are used up, the algal blooms die. The break down or decaying of the dead algae uses oxygen, which reduces the amount available for use by aquatic animals. This can cause fish to die, and further degrade the water quality. Eutrophication and the filling in of a water body can also reduce flood storage capacity and hydroelectric potential of a water body.

Human activities can greatly increase the rate at which eutrophication happens. Non-point sources of nutrient enrichment include yard fertilizers, livestock wastes, pet feces, failing septic tanks, and eroded soil. Phosphate detergents can enter waterways through storm drains from improperly treated wastewater as well as from the use of soaps and cleaners

on sidewalks and driveways. When it rains, storm water runoff carries soil and nutrients into water bodies. (Phosphates usually travel into water bodies attached to soil. Nitrate fertilizers are water soluble; they can dissolve directly in water and don't always travel to water bodies attached to soil particles.)

Getting Ready:

1. Purchase granulated fertilizer of equal nitrate and phosphate concentration at a garden supply store.

2. Within a few days prior to the experiment, obtain several gallons of pond or stream water (depending on the class size) and store in a cool place until ready for use.

3. Make copies (1 per student) of the Student Data sheets.

Doing the Activity:

1. Begin by asking the students what they know about fertilizers. Why and where are they used? What are they made from? Do they occur naturally or are they manufactured? List students' responses and help fill any gaps in their information.

2. Discuss eutrophication. Where might the nutrients come from? Explain that eutrophication happens naturally, but can also be accelerated by human activity, such as the improper use of fertilizers. How might fertilizer or another outside source of nutrients, get into the water? How might the water quality change? How might it affect fish and other wildlife?

3. Explain that students will have the opportunity to observe the various effects of nutrient enrichment on water quality by conducting a controlled experiment. Emphasize the need for careful observation and record keeping, as well as safety.

4. Divide students into groups of three or four, and give each student a data sheet and safety goggles. Give each team three clean 1-quart jars. Have students label each with masking tape or labels. Number the jars from 1 to 3 with a marking pen. Container #1 will be the control.

5. Fill each jar 2/3 full with pond or stream water. To jar #2, have each group add 1 teaspoon of fertilizer. To jar #3, add 2 teaspoons of fertilizer. If students are going to perform dissolved oxygen (DO) tests have them do so in jar #1. Students should record their findings on the data sheet.

6. Place a piece of paper towel over each container and place them in a sunny location so that each container receives the same amount of light. Use a sun lamp or grow lamp if sunlight is unavailable.

7. Use the data sheet provided to record daily observations (for thirty days) for all three containers. Data collected should include observations on color, clarity, and odor of the water. Photos can be taken to record changes as well.

8. On day thirty, have students make regular observations. In addition, students should perform DO tests on all three samples, and record their findings.
9. When the experiment is completed, have the students answer the following questions based upon their observations:

- What changes did you observe?
- How long did it take before changes in the control and in each test jar were observed?
- After five days, how did the contents of the jars compare?
- After ten days, how did the jars compare?
- How did the DO tests compare from day 1 to day 30? Between samples?
- Did they follow your predictions?
- How might you explain these observations?
- Is there a correlation between DO and algal growth?
- How might this affect aquatic animal life? Plant life?
- What can or should be done to control non-point sources of phosphate and nitrate compounds in runoff?
- What can you do?

Extensions:
1. Have the students identify the type(s) of algae that grew using algae identification charts, microscopes, slides and commercially prepared algal sides.

2. Perform a larger-scale study on the effects of nutrient enrichment using plastic wading pools as artificial ponds. Add different amounts of nitrate and phosphate fertilizers, manure (be careful of pathogens), phosphate detergents, grass cuttings, etc. Be sure to leave one pond as a control. Have students answer the above questions. Have the students compare what goes on in these "ponds" to what happens in local water bodies.

3. Have students obtain water samples from a variety of water sources, including lakes, local streams and/or stormwater runoff (roadside ditches, discharge points into streams, parking lot runoff). Take samples from waters that appear to be eutrophic and at least one from water that appears to be oligotrophic or from areas you suspect may be impacted by runoff pollution despite their appearance. Label each sample with time, date, and location. Record sampling locations on a map or sketch and describe each sampling site. Survey the area and note possible non-point sources of pollution. Test each sample for nitrate and phosphate levels using commercial kits. Compare the results of the test to your observations from each sampling site.

4. Explain to the class what Best Management Practices are and how they can help prevent non-point pollution. Use the following website and discuss different methods used by farmers. (http://www.mrsc.org/Subjects/Environment/water/SW-BMP.aspx) Over a period of a week, have the groups interview local farmers on what types of Best

Management Practices are used on their land. After learning of local Best Management Practices, have groups develop their own Best Management Practices. Have each group present their ideas and findings to the class in a 10-15 minute powerpoint presentation.

Student Data Sheet

Name_____ Date_____

Water Sample

Date collected_____ Location collected_____

Day	Sample Number		
	1	2	3

AP Stormwater Pollution Lesson Plan

Stormwater Pollution: Integrating Science and Civics

Purpose:
This exercise will expose students to the ways in which stormwater pollution affects different members of our society. Science will be integrated with government and policy through the exploration of an environmental problem.

Objectives:
(1) Students will be able to state at least 3 types of people stormwater pollution can affect.
(2) Students will demonstrate knowledge of stormwater pollution issues through small group discussion.
(3) Students will be able to write a professional-style letter expressing appropriate interest in stormwater pollution issues.

Materials: index cards

Vocabulary: erosion, fertilizers, runoff, urban stormwater pollution, water quality, and watershed.

Activity:

1. Explain the causes and effects of urban stormwater pollution and initiate a classroom discussion about possible local pollution issues.

2. Create a stack of environmental problem playing cards. Each card should have a different environmental problem related to stormwater pollution written on it. The following list provides a few examples of stormwater pollution issues.
   - Mr. Johnson changes the oil in his truck every few months on the street in front of his house and disposes of the oil in the storm drain.
   - Ms. Paige uses industrial strength soap to wash her car every Sunday on her driveway.
   - Walter uses twice the recommended amount of fertilizer on his lawn just before a big rainstorm.
   - Flower City Development Inc. is building an apartment building on the side of a creek and has no controls in place to keep soil from eroding into the creek.
   - Genesee Widgets Company is storing materials in a way that is resulting in oils and metal shavings being washed into a nearby storm drain when it rains.
   - Additional examples can be found by having the students explore the Stormwater Coalition web site at www.h2ohero.org

3. Break class into groups of 4 students. Have one student from each group come

and draw one of the environmental playing cards. This card will give each group in the class a different issue.

4. Assign each member of the groups one of the following roles:
   - Monroe County Stormwater Program Manager
   - Responsible Party (person or company responsible for the stormwater pollution)
   - Biologist/Environmental Scientist
   - Everyday Concerned Citizen

5. Depending on available time, choose one of the following methods for having students learn about their roles.
   - Have each student spend time on the internet researching the role he or she is assigned.
   - Provide students with brief descriptions of the roles that have been assigned.
   - Invite your municipalities stormwater manager to your class.

6. Have students in each group engage in a discussion about the effects their stormwater pollution issue might have on the different roles they are taking.

7. Have students playing the Responsible Party, Scientist, and Citizen write a letter to the Stormwater Program Manager, and have the student playing the Stormwater Program Manager write a letter to the Responsible Party. The letters should address the situation from the letter writer's perspective and propose solutions.

Alternative/Expanded Role-Playing Activities:

A teacher may expand this activity to include a broader range of roles and role-playing scenarios.

Examples of roles include:

- Pollutant
- Aquatic organism (e.g., fish)
- Biologist
- Environmental group
- Everyday concerned citizen
- Environmental Engineer
- Residential developer
- City official
- State Stormwater Program Manager
- EPA (Federal) Stormwater Program Manager
- Federal Judge
- Congressional Representative

The teacher can guide the class through whatever scenario he/she chooses. For example, the role-playing might begin with the pollutant(s) telling us who they are, and where they came from. The aquatic organism may respond adversely and be noticed by the biologist or everyday citizen. They bring it to the attention of the city official. Meanwhile, the engineer and developer are also in the ear of the city official. The city official consults the State Stormwater Program Manager who, subsequently, requires a new best

management practice as part of their municipal permit. If this fails to resolve the pollution problem, the EPA Project Manager may intervene. Other options may include the concerned citizen riling up their favorite environmental group to sue local governments for failure to resolve the situation…in steps the judge. If no solution is found, the congressman might have to draft a new bill that will set new policy for the EPA Project Manager to implement through the Executive Branch.

This activity could involve verbal classroom presentations and discussion, or be conducted in a journal passed between classmates. This activity is also a great opportunity to integrate the content areas of science and civics as the early scientific/factual "steps" in the process leading to government policy development and implementation. This activity could also be a lead-in to your school's mock-trial exercise.

Probing Into Pesticides

Overview:
Through interviews with local professionals* and research students will understand the uses of pesticides, insecticides and fertilizers, and learn about their potential to pollute when used improperly.

*Professionals might include staff from your local cooperative extension or soil and water conservation offices, and pesticide consumers such as local farmers or landscape contractors.

Skills:
Researching, Interviewing, Analyzing, Collecting Information

Objectives:
Students will:

1) Research and describe the purpose of common chemicals (pesticides, insecticides and fertilizers) used by farmers and home gardeners

2) Interview farmers and homeowners to gather data on how common pesticides, insecticides and fertilizers are used in their work or home, and measures they take to prevent stormwater runoff pollution

3) Determine if pesticides, insecticides and fertilizers are being used correctly to minimize the risk of stormwater runoff pollution

4) Understand the consequences of improper pesticide, insecticide and fertilizer use

5) List examples of safe pesticide, insecticide and fertilizer use

Materials:
Paper, pencil, posterboard, scissors, glue, Internet access, farming magazines, chemical pamphlets, cooperative extension publications, and factsheets from local co-ops

Time Considerations:
2-3 class periods

Setting/Group size:
Classroom, any size

Safety Considerations:

Caution students not to bring to class packaging containing pesticide residues.

Background:
Each year about three billion pounds (1,362,000 metric tons) of pesticides are used in the United States. Pesticides are beneficial because they can improve crop yields significantly by controlling weeds, insects and plant disease. Farmers are by far the largest users of pesticides, and some could not remain in business without them. However, homeowners over-apply pesticides more often than farmers. Because pesticides are designed to kill living organisms, they can cause serious health and environmental problems if not used properly. Some pesticides stay in the environment for long periods of time and may travel from the soil into surface waters via stormwater runoff. Some pesticides continue to move up the food chain from single-celled organisms and insects to animal and humans. Under the US Federal Insecticide, Fungicide and Rodenticide Act (FIFRA), the Environmental Protection Agency (EPA) is responsible for controlling the risks of pesticides through a registration process. This registration process only ensures that when a pesticide is properly used, it poses no unreasonable health or environmental risks. It is up to the person applying the pesticide to make sure it is used properly. However, the best way to limit stormwater pollution from pesticides is to limit their use to an as needed basis and consider safer alternatives such a biological controls and resistant plant species.

Doing the Activity:
1. Began by asking the students what they know about pesticides and fertilizers. What are they made from? What is their purpose? Who uses them? How are they used? Where are they used?

Have each student interview at least one farmer, gardener, horticulturist, nursery employee, agricultural extension agent, or other person who might use the chemicals. Local farm markets would be ideal for locations to interview farmers. Some suggestions for interview questions include:

- What crops do you grow?
- How many acres of land do you cultivate? (square feet for home gardeners)
- Do you use any pesticides or fertilizers? List them.
- What is the purpose of each?
- How is each applied?
- What precautions do you take when applying them?
- How do you know how much to use?
- When do you use them
- Are there alternatives? Are they effective? Are they more costly?

Note: For homeowners, this should include lawn care pesticides and fertilizers.

2. After the interviews, the students should compile the information into a chart. On the chart, identify the chemical, what it is used for, who uses it, how it is applied, and what precautions are taken to reduce the chance for stormwater runoff pollution.

3. A group of three or four students should investigate each chemical. Have them find out what the chemical is usually used for, who typically uses it, if it requires a license for use, how long does it persist in the environment, and if its approved by the EPA. Other questions could include:

- Do alternatives exist or are they being developed?
- Are there consequences to over use of this chemical? List them.

4. If possible, students can get a copy of the instructions and warning labels of each. These can be obtained at the farmers' co-op, garden center, cooperative extension agency, soil conservation office, the local home center or by contacting the Stormwater Coalition of Monroe County.

5. Have the groups investigate the impact these chemicals might have if stormwater runoff becomes contaminated and they are released into aquatic environments.

6. Have the groups make posters showing information they gathered and share with the rest of the class. As a class, compare the information gathered in the interviews to that gathered in the research. Discuss the following:

- Are the people you interviewed using the chemical correctly? Are any using alternatives?
- Are the chemicals being used dangerous?
- Can a gardener/farmer be successful without pesticides?
- What might happen if some of these chemicals were to wash into streams, lakes or groundwater?
- What impacts might pesticides or excess fertilizers have on fish and wildlife? humans?
- What are some alternatives to pesticides? How can people reduce the harmful impacts of pesticides?

Extensions:
1. Organic farming is a method of farming without the use of chemical pesticides. Have the students research organic farming, and learn the costs and benefits to organic methods.

Assessment ideas:
1. Have the students produce a brochure, news article, cartoon or video regarding the beneficial and harmful aspects of pesticides and fertilizers and suggest alternatives.

Adapted from
Salt Lake County Storm Water Quality Education Lesson and Activity Plans
3rd Edition - December 2005

NAME: _____

DATE:_____

CLASS:_____

Storm Drain Mapping and Monitoring

Background

The storm drain system is an interconnected system of pipes and ditches that collect and carry runoff to a nearby waterbody. The water is not treated in any way during transport through the system, therefore, it is important to know the extent of the system and monitor it for signs of pollution.