Storm Water Curriculum & Teaching Guide

Earth Partnership for Schools,
University of Wisconsin-Madison Arboretum
& Madison Area Municipal Storm Water Partnership

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Storm Water Curriculum & Teaching Guide

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Earth Partnership for Schools Program
University of Wisconsin-Madison Arboretum
1207 Seminole Highway
Madison, WI 53711
608-262-9925
www.uwarboretum.org

Principal Author
Cheryl Bauer-Armstrong
cherylbauer@wisc.edu

Principal Editors/Contributors
Danielle McFarland, Libby McCann, Carol Edgerton,
Molly Fifield Murray, Marsha Hartwig, Suzanne Wade, and Mindy Habecker

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Introduction

We all live in a watershed and play a role in the health of its land and water. One way to take part in a healthy watershed is for all citizens to understand storm water issues and take positive steps to improve water running over the land in their communities. Storm water has become one of the greatest problems to the watershed environment. The purpose of this *Storm Water Curriculum & Teaching Guide* is to teach students about storm water, its impacts and how to reduce those impacts. This unit is designed for 6th grade and can be adapted to a wider range of grades. The primary focus of this unit is urban, developed landscapes. Rural areas also face serious storm water issues; these issues are mentioned but not fully addressed. This guide is a three to five day curriculum unit, which includes background material, related activities, student learning assessment ideas, teacher resources and extensions, student resources, and vocabulary.

The Objectives of the Storm Water Curriculum & Teaching Guide Are to:

- Raise awareness of storm water impacts in the local watershed
- Understand the environmental, economic and social concerns related to storm water
- Promote discussion and communication to improve the quality of storm water at school, at home and in the community
- Improve skills to identify storm water impacts and how to solve them
- Apply concepts learned to address storm water quality issues through service learning projects

Figure 1: Community members plant a rain garden to encourage rain water coming off the roof to soak into the ground rather than enter a storm drain. Source Jim Lorman.

Concepts: watershed, water cycle, land and water dynamics, storm water, point and nonpoint pollution, habitat, water pollution impacts, water quality regulations, citizen responsibility

How to Use the Storm Water Curriculum & Teaching Guide

This unit is developed to be flexible to meet teachers' needs and schedules, as well as students' needs and abilities. Alternative and/or extension activities are listed and described under Resources for Teachers. The background information is written for teachers, yet may be used as a student handout for assigned reading.

This unit may stand alone or be used as a foundation to explain the challenges and solutions of storm water for schools implementing a storm water management practice such as building a rain garden on the school grounds. A separate and compatible unit for building a rain garden with students is available though Earth Partnership for Schools, UW-Madison Arboretum (www.uwarboretum.org).

RECOMMENDED LESSONS, ACTIVITIES AND TIMELINE

Day 1 (one 50-minute class period)

- Activities
    - PowerPoint Presentation: Introduction to Storm Water: Impacts to Solutions. Introduces students to storm water impacts and solutions. Subjects addressed: science and social studies.
    - Activity: Water in a Watershed. Students participate in a demonstration to learn about watersheds, runoff and pollution. Subjects addressed: science and social studies.

Days 2 & 3 (two 50-minute class periods)

- Activities
    - Follow the Drop (Storm Water on School Grounds) Students observe and collect information about water runoff on their school property and estimate volume of surface runoff after a rain event. Subjects addressed: science, social studies, and math.
    - "Water" You Doing with Hydrology? (A Water Inventory) Students assess the potential risks to water from storm water runoff coming off their school or home properties. Additionally, students evaluate water usage at home or school. Subjects addressed: science, social studies, and math.

Day 2

a) On school grounds – Students determine water movement on the school grounds and measure pervious and impervious surfaces.

Day 3 (one 50-minute class period)

b) In the classroom – Students calculate volume of water on school grounds after a rain event.

c) In the classroom – Students learn how to fill out Water Inventory forms as homework.

Days 4 & 5 (two 50-minute class periods)

- Activities
    - "Water" You Doing with Hydrology? (A Water Inventory)
    - Outreach Materials: Creating Solutions to Storm Water Pollution. Students write and develop outreach materials such as a brochure, fact sheet, article or poster identifying a storm water impact or water usage issue in the community and offer suggestions to engage community members in solutions. Subjects addressed: language arts, science, and environmental science.

Day 4

a) In the classroom – Students compile water inventories and identify the most common problems. Students explore and discuss solutions to those problems. Students form teams to develop a brochure, fact sheet or article that addresses the storm water concern and offers suggestions for change. Students determine an audience for their informational materials and decide how to distribute them. (Possible ideas for dissemination are listed under activity description.)

b) As homework – Student teams develop their brochure, fact sheet or article. Due date determined by teacher.

Day 5

c) In the classroom – Students present their brochures, fact sheets or articles.

d) Students distribute their materials/information to the community via their chosen dissemination method.

BACKGROUND

What Is Storm Water?

Storm water is precipitation running or flowing over the land plus anything carried along with it. Storm water comes from all forms of precipitation – rain, snow, sleet or ice melt. In urban areas, precipitation falls on hard (or impervious) surfaces like roofs on houses and other buildings and paved areas such as driveways, streets and parking lots. The water flows over these hard surfaces collecting such things as excess nutrients, toxins, bacteria and trash. The water then flows through a system of pipes or ditches that go directly into lakes, rivers, small streams and other types of waterways. In rural areas, water running over poorly managed farm fields and pastures, and barn or feed lots picks up manure, soil, fertilizer and pesticides that flow into waterways. Storm water is not treated like waste water at a treatment facility. Water used for flushing toilets or washing dishes first goes to a treatment plant where it is cleaned then released. In contrast, storm water goes straight into waterways inhabited by turtles, frogs, fish, other aquatic animals, and plants. Waterways fed by storm water may become a health risk to swimmers and people fishing.

Some cities such as Milwaukee face a different problem with storm water. Storm water and waste water are actually combined and taken to a treatment facility. You may think, “that’s great, the storm water will be cleaned of pollutants before entering local rivers and Lake Michigan.” The problem arises when there is a heavy rain, and the facility can not keep up with the large volume of water. Then the pipes overflow, sending untreated sewage along with the storm water directly into the rivers. These overflows create larger and more serious pollution problems than storm water alone.

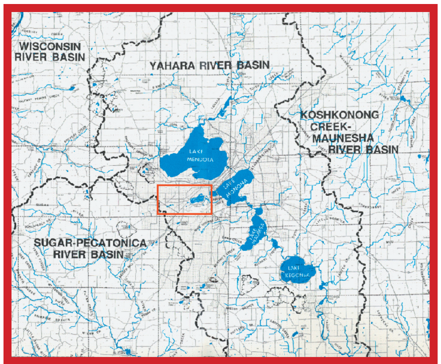
Storm water is not a new concern for human cultures. Ancient Roman and Greek civilizations built roadways that slanted towards ditches to direct storm water off the streets. The Romans also built curbs and gutters to direct water. Some of these Roman storm water structures are still in use today. For the first time, in the late 1800s, storm water was sent underground through clay, and later, cement pipes. This pipeline system was created in response to water-born illnesses and disgusting odors coming from open ditches carrying both storm and sewage water. Since then, funneling storm water in pipes was seen as a fairly easy and quick solution to transport storm water away and out of sight. Unfortunately, storm water does not disappear, and the consequences are polluted streams, rivers, and lakes among other problems.

The good news is that storm water pollution can be controlled. Today we are learning better ways to manage storm water rather than sending it untreated directly to waterways.

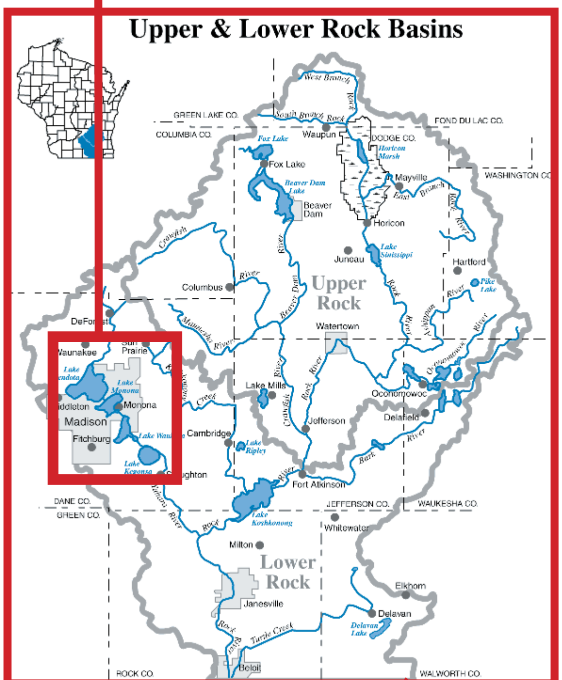
Before discussing issues, impacts, and solutions concerning storm water, some broader concepts will be defined such as what is a watershed, how is it related to the larger water cycle and how does land use affect the dynamics of water and land in the watershed.

What Is a Watershed?

A watershed is an area of land where water flows downhill from high points to low points. This low point is typically a lake or river. Watersheds can be small, such as the land draining to a pond or creek, or it can be quite large such as all of the land that drains to Lake Mendota. Very large watersheds such as the area draining to the Wisconsin, Rock or even the Mississippi are often called a Basin. Since water usually flows from small ponds, streams or lakes to bigger streams and eventually rivers, the smaller watersheds nest inside the larger ones. These small watersheds are often called sub-watersheds.



Watersheds are separated from each other by divides. A divide can be very large such as the well known Continental Divide of the Rockies, where on one side the water flows to the Pacific Ocean and on the other side it flows to the Gulf of Mexico and eventually to the Atlantic Ocean. A divide can be quite hard to see when it is just a small hill or ridge between two streams. In both these examples, water on one side of the divide flows towards one water body and on the other to a completely separate water body.



The Yahara Watershed fits inside the Rock River Basin along with many other sub-watersheds such as Koshkonong Creek, and the Crawfish River. The Rock River Basin is one of many watersheds or basins that are part of the Mississippi Basin. See Figure 2.

Everybody lives in a watershed. The quality of the water in a watershed is a reflection of what happens on the land. So all of the living and nonliving things within its boundaries – plants, animals, hills, valleys, people, farms, businesses, cities and towns along with all of their activities affects water quality. See <u>Student Resources</u> section to find your watershed and some of the activities happening in it.

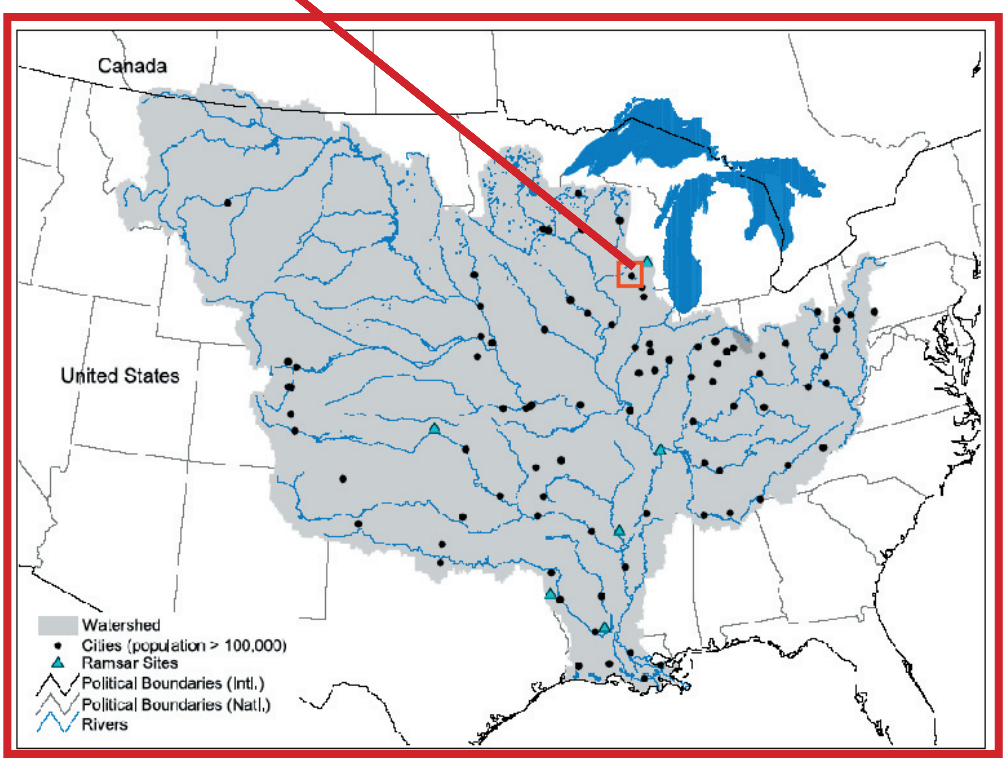


Figure 2: The Yahara Watershed fits inside the Rock River Basin, which fits in the Mississippi Basin. Source Dane County/UW Extension.

Water that enters the watershed as rain, snow, sleet or hail eventually exits in rivers or soaks into the ground (infiltrates) and is part of a large global cycling of water that is constantly in motion. The journey water takes is called a water cycle and is further defined in the following section.

What Is a Water Cycle?

Water moves around the earth in a cycle as it changes from a solid, to a liquid, to a gas over and over again. These changes are all part of the water cycle, which is also known as the hydrologic cycle (see Figure 3). More specifically, water evaporates from the ocean and fresh water bodies, such as rivers and lakes, into the atmosphere. The water vapor condenses into water droplets as clouds. As the droplets grow larger, they precipitate and fall to the earth as liquid rain or frozen sleet and snow. Once the water falls to the earth, some of it will flow down hill on the surface of the land as runoff to rivers, lakes and ponds. Small streams flow into large streams which flow into rivers that eventually flow to the ocean. Some water soaks (infiltrates) into the ground through the soil and rocks. If the water infiltrates deeply, it may become ground water or may flow under the ground and return to the surface of the ground in rivers and lakes or springs. Some of the water is taken up by plants through roots, stems and leaves. Water inside the leaves moves into the air as vapor through transpiration. These six revolving processes – 1) evaporation from surface water, 2) condensation into clouds, 3) precipitation as rain, snow, sleet or fog, 4) infiltration into the soil, 5) water flow over the surface or in the ground, and 6) transpiration from plants – make up the hydrologic cycle.

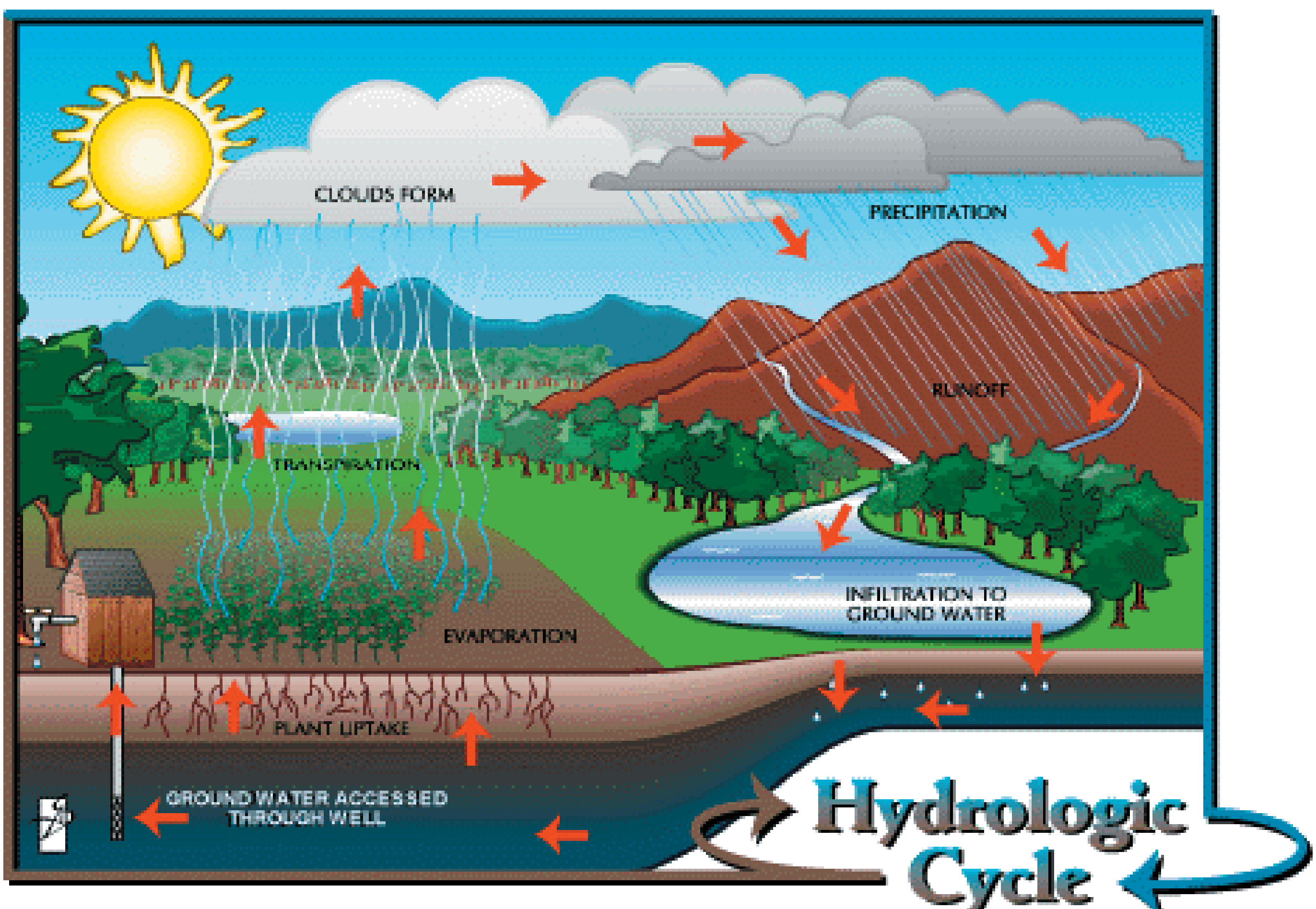


Figure 3: Water continuously cycles between the atmosphere and the land. Notice the well pumping water from the ground. What do you think happens when more water is pumped from the ground and empties outside the local watershed? Source US EPA.

How Does Land Use Affect the Dynamics of Water and Land in the Watershed?
Surface runoff is a natural part of the hydrologic cycle. In a natural undeveloped setting, only a small quantity of rain that falls to the earth becomes surface runoff. Instead, most of the water infiltrates or soaks down into the soil. Most soil in the Midwest is permeable with open spaces where rain water can permeate or seep into the ground. However, in developed areas, these porous natural surfaces are often covered with concrete, asphalt, buildings and other impervious materials where water is not able to infiltrate. These hard surfaces change the dynamics of water flow on the landscape and alter the hydrologic cycle. With each new road, sidewalk or building, less water infiltrates and the quantity and speed of surface runoff increases. Only a 15% change from a natural vegetated landscape to hard surfaces seriously affects water quality and flooding potential. See Figure 4 to compare the relationship between impervious cover and surface runoff. Notice in the diagram how with each increase of impervious surface on the land, surface water amplifies and infiltration diminishes.

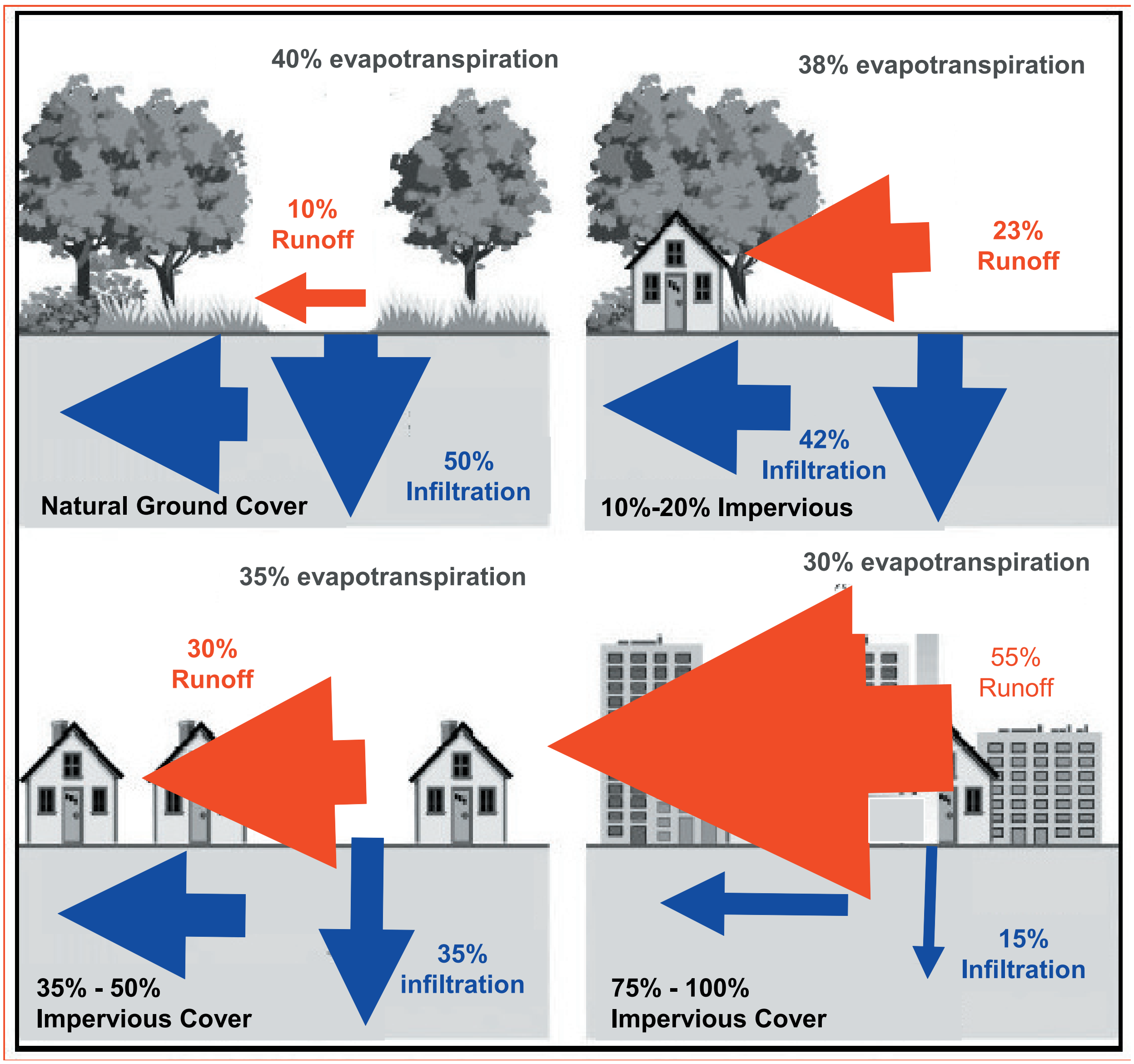


Figure 4: Relationship between impervious cover and surface water runoff. All other processes are reduced as surface runoff increases. Can you guess why increased impervious surfaces reduce evapotranspiration? Illustration from: Federal Interagency SRWG.

Rain and snow typically recharge groundwater. Less infiltration means less groundwater recharge. Groundwater is where all the spaces between soil, gravel and bedrock are filled with water; these waterlogged areas are called aquifers. The top surface of groundwater is called the water table. When water runs off instead of soaking in, the water table drops.

When groundwater levels decrease, it impacts the water cycle. Less water is available for base flow in streams or lakes. This is the water that moves naturally from the groundwater into streams and keeps water in them year-round. When groundwater levels drop, it can also mean drying up of wetlands. In many cities, streams that used to run year-round now dry up each year. Dropping water levels also affect people who live in rural areas and get their water from private wells. People that live in cities get water from very deep wells, where water quantity is usually not a problem.

What Are the Environmental, Economic and Social Concerns with Storm Water?

Polluted water enters lakes and rivers two ways: point source and nonpoint source pollution. Point source pollution comes from an identifiable point or source such as a pipe or drainage ditch, and the pollutant and its source is known. Nonpoint source pollution (NPS) comes from many places, and the source cannot be identified. Storm water is considered non-point source pollution. Examples of NPS pollutants are runoff coming from fertilized agricultural fields in rural areas or runoff coming from streets and parking lots in the city. Some people believe that water pollution is largely due to factories discharging polluted water from a pipe. Thanks to water quality regulations along with environmentally concerned businesses, this is no longer true. Instead, nonpoint sources of storm water are the significant contributor to water pollution today.

The most obvious effect of storm water is on the environment. Both trained and untrained eyes can see water clouded with sediment, dead fish on shorelines, water green with algae and washed-out hillsides and stream banks. Storm water affects our community on a social level, too. Public recreation on waterways is restricted by beach closings or limits on fish consumption from fish contaminated with toxins in storm water. Storm water is costly, too. All taxpayers are affected through higher taxes that pay for storm water related problems. The following section highlights some of these concerns.

Environmental Concerns

Toxins in the water: Storm water washing over parking lots and roadways picks up antifreeze and oil dripped from cars, petroleum products, and heavy metals such as copper, cadmium, chromium, lead and zinc. Toxins have a wide range of negative health effects to birds, fish, other animals, and people.

High salt concentrations: Road salt contains sodium and chloride (NaCl). Road salting began about the 1950s in most communities. The levels of NaCl are rising in many lakes. Elevated levels slow water absorption in plants, limit seed germination, reduce root growth and reduce diversity in wetlands by favoring salt-tolerant species.

Algae blooms: Both algae and blue-green algae (*cyanobacteria*) occur naturally in surface waters. Although they are usually microscopic, when nutrient levels are too high and conditions are ideal, both can reproduce rapidly and undergo a phenomenon known as a “bloom.” Common algae are not toxic to humans or animals. In contrast, some forms of *cyanobacteria* can be extremely toxic and capable of causing serious illness or even death. As these algae decay they create nasty odors and cause oxygen depletion in the water.

Oxygen depletion (OD): Excessive nutrients (especially phosphorus) coming from eroded soils, leaf litter, field and lawn fertilization, poorly managed manure, and streets cause explosions of plant and algae growth in the water. As plants decay, bacteria feeding on them use up oxygen, taking away essential oxygen from fish and other aquatic animals. Oxygen depletion sometimes causes fish kills.

Thermal pollution: As storm water runoff flows over hot paved surfaces, the water heats up. The warmed water enters waterways and can change the composition of aquatic populations, reduce reproduction rates, and reduce oxygen availability. Trout in cold water streams are particularly affected by thermal pollution. Western Dane County and the Token Creek area have special rules for land developers to reduce thermal pollution.

Sedimentation: The increased volume and intensity of storm water over the land leads to erosion of soil from farm fields, gullies, construction sites, and stream banks. Other sources of sedimentation are new construction, poor farming practices, and the addition of sand and grit on roadways in winter. Sediment accumulates in the water leading to waterways being filled up and smothering bottom dwelling aquatic communities. Cloudy water from sediment suffocates fish by clogging their gills.

Habitat destruction: Natural areas and habitats become degraded by surges of water and sediment. Habitat destruction is also caused by invasive, non-native species that are transported by storm water. These aggressive species push out the native plants that provide nutritious food, safe cover, and space for native wildlife.

Decrease of base flow and water input in springs and wetlands: Increased impermeable surfaces means less water infiltrates into the ground, which causes low stream base flows. Normally during dry periods, ground water is available to feed steams. If not, the streams completely dry up, and all aquatic habitats are lost. The lack of recharge similarly affects wetlands and springs.

Alteration of hydrology dynamics: When more water flows over the surface because of human land use, water volume and speed build during a storm. These rainwater surges cause flooding, stream bank erosion, sedimentation, and uproot trees and plants. In addition, less water infiltrates into the ground where it slowly releases to the stream overtime. See Figure 5 to compare what happens during a rain in a natural area with a normal water flow to a developed landscape with an altered rate flow.

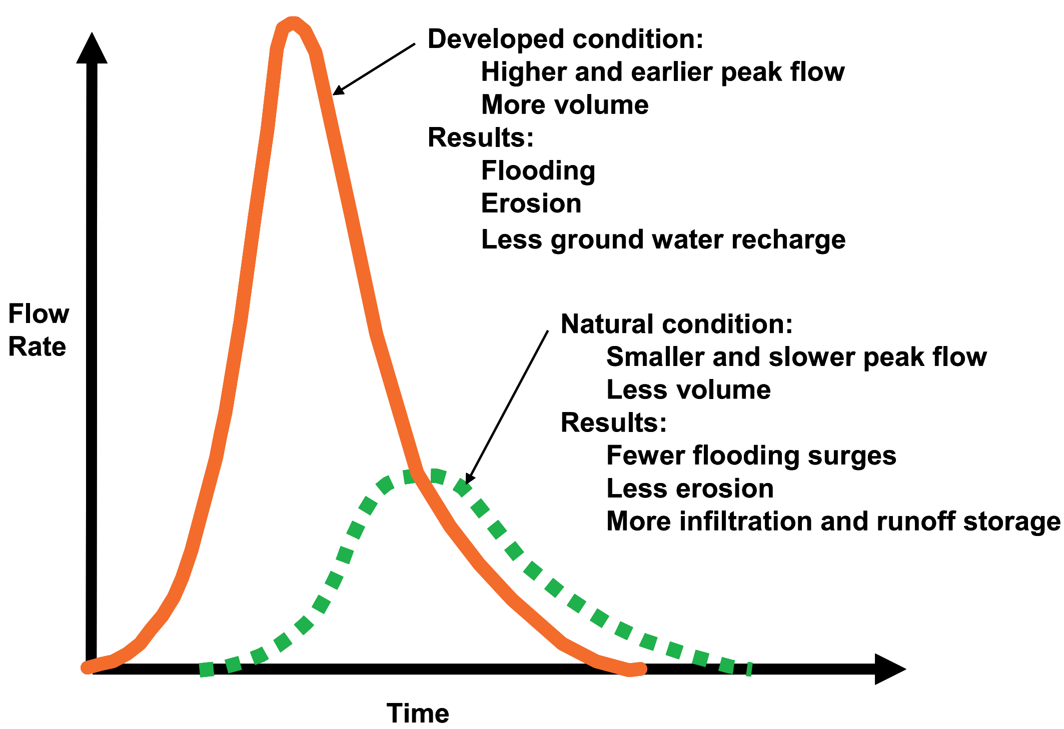


Figure 5: This hydrograph compares storm water flow between developed and undeveloped land. Notice the increase of storm water and how quickly it begins moving on the developed land. Adapted from Wisconsin Rain Garden Educator's Kit, University of Wisconsin Extension & Wisconsin Department of Natural resources.

Social Concerns

Human activities on the land have consequences: positive, negative or even neutral. Many of the current ways we manage storm water have an overall negative affect on our health, safety, and recreational activities. The following lists some of the social concerns connected to storm water:

Illness – Pathogens (disease-causing organisms) such as *E. coli*, fecal coliform, *Giardia* and *Cryptosporidium* come from warm-blooded animals and cause severe human illness. These organisms enter waterways and drinking water through storm water. In 1993, 403,000 people were sickened and 111 died from drinking water contaminated with *Cryptosporidium* in Milwaukee. High levels of *E. coli* and fecal coliform around beaches make swimming unsafe. Common sources of high bacteria levels in urban runoff come from pet wastes, goose and gull droppings and improperly treated sewage. Sources of rural storm water contamination come from livestock operations and manure spreading on farm fields. Bacteria in beach water can cause hepatitis, dysentery, gastroenteritis and respiratory ailments.

Figure 6: Swimmers at Vilas Beach on Lake Wingra, Madison, WI. The beach was closed most of the summer in 2003. Source Friends of Lake Wingra, Inc.

Beach closings – Beach closings are on the increase in Wisconsin due to high concentrations of E. coli and fecal coliform bacteria usually following a rain. Between 2003 and 2004 beach closings multiplied by 33% (The Capitol Times, July 29, 2005).

Fish consumption – Over-consumption of fish caught in waterways also poses health concerns. Toxins from storm water build up in fish, especially predatory fish high in the food chain (e.g. musky, walleye, northern pike). The Wisconsin DNR has set limits for weekly fish consumptions to limit long-term health risks to humans (http://www.wisc.edu/foodsafety/assets/pdf_Files/Fish_consumption.pdf.).

Public safety due to flooding – Flooding is more frequent and severe because less water infiltrates and surface water increases in volume and speed in a short period of time. See Figure 5 and discussion about alteration of water dynamics on page 8. The devastation from flooding associated with storm water damages homes and businesses, destroys bridges and roads, and harms human life. A memorable example of serious flood damage happened in the Midwest in 1993. After heavy rains, the Mississippi River expanded its width 10 to 20 times and covered the land with 15 feet of water. Forty thousand people were left homeless, and fifty people died.

Consequences to down stream neighbors – Families and communities living downstream are affected by the actions of their upstream neighbors. Anything entering the system upstream ends up somewhere downstream; be it trash, sediment, oils or grease. As additions collect along the way, downstream neighbors are burdened more and more.

Loss of recreational activities – Storm water can turn lakes green with algae, which create foul odors that ruin enjoyment of water-based activities. Storm water pollution destroys the aesthetic beauty of waterways. Weeds clog boat motors and affect the ability for anglers to cast and catch fish.

The following chart, Figure 7, identifies pollutants and their sources. Which pollutants are evident in your community?

Pollutants	Sources
Heavy metals (i.e., zinc, copper, lead, cadmium, chromium)	- Vehicles – wear and tear of brakes, tires and body frames, and exhaust - Paints, metal plating, galvanized steel from bridges, buildings, and other structures - Industrial discharges
Hydrocarbons (i.e., petroleum products, oil, grease, gas, etc.)	- Vehicles - Automobile service stations - Spills and leaks - Improperly burned fuels
Fertilizer, pesticides, herbicides	- Lawns - Farm fields - Products over applied, spilled or applied before a rain
Excessive nutrients (i.e., phosphorus, nitrogen)	- Leaf litter in street gutters - Sediment from eroded soils - Lawn care – grass clippings, fertilizer
Salt, sand and ash	- Substances used to melt ice on roads and sidewalks
Bacteria and other disease organisms (i.e. *E.coli*, fecal coliform, blue-green algae, *Giardia, Cryptosporidium*)	- Pet, goose and gull droppings - Improperly treated sewage - Failing septic systems - Garbage
Arsenic and mercury	- Fossil fuel combustion
Asphalt and tar	- Pavement (i.e. roads and parking lots)
Atmospheric fallout (or airborne matter that settles on land surfaces)	- Dust - Burning fossil fuels (coal power plants, automobiles and planes) - Exposed land - Contaminates from smoke stacks
Hazardous materials (i.e., paint thinner, lacquers, wax resins, detergents, etc.)	- Manufacturer and industrial spills or leaks - Domestic consumer spills or leaks
Discarded garbage (i.e., litter deposited by humans)	- Sides of highways and roadways - Recreational areas - Shorelines and beaches - Storm sewers
Combined sewer overflow	- Combined sanitary and storm sewer systems that overflow during heavy rain events
Sedimentation	- Construction sites - Poor farming practices - Exposed soil
Thermal	- Runoff from hot pavement - Industrial waste water

Figure 7: Sources of Storm Water Pollutants. Adapted from Home*A*Syst, NRAES.

Economic Concerns

Storm water management and damage repair is very expensive for cities, towns, states and our country. A few of the costs and concerns follow:

Storm water infrastructure – Building and maintaining pipes, culverts, and detention ponds costs millions of dollars. Many communities are now billing residents for storm water management fees to help pay these costs. These charges are often called a storm water utility fee on water bills. Depending upon the community, homeowners can pay at least $36 each year, while businesses pay even more (2005 fees). What do property owners in your community pay?

Figure 8: Dredging sediment from clogging a river. Source Wisconsin DNR.

Dredging – Storm water washes out soils creating “sediment deltas” at the end of storm water pipes or in streams and rivers. Often these deltas restrict recreational boaters’ use of waterways and fill commercial shipping channels. Dredging, or the removal of sediment, is needed to produce sufficient depths for navigation. Ongoing expensive dredging and the need for safe disposal of the “spoils” (which may be contaminated with heavy metals and toxins) is only a temporary fix. After awhile the deltas rebuild and need to be removed again.

Aquatic weed control – Aquatic weeds are flourishing in Wisconsin lakes and rivers from excessive nutrients spread on lawns and fields. Explosions of aquatic plants are a nuisance to boaters and other water users. Mechanical (weed harvesting), manual (pulling) and chemical controls (herbicides) are used to remove weeds, each bringing specific costs and risks.

Loss of recreational activities for private businesses – Wisconsin is a vacation destination because of its numerous lakes and rivers. When lakes are full of sediment and unsightly weeds, and rivers are scoured and banks eroded, vacationers choose to go elsewhere, which hurts Wisconsin’s tourist industry. Water-based tourism brings Wisconsin $12 to $15 billion dollars every year (2006).

Groundwater depletion – With less water recharging groundwater through infiltration, private and public wells need to be dug deeper at substantial costs. In Dane County, groundwater pumping is greater than recharge, currently creating a 60 foot drawdown of the water table. Additionally, a risk of contamination of groundwater by arsenic, radon and salts is possible as the water table lowers.

Clean water has a value that is being degraded – Clean water is necessary for supporting life, and it has value on its own. Polluted storm water compromises its worth.

What Are Governments Response to Improve Water Quality?

Healthy watersheds assure a healthy future for the environment, the economy and society. Along with activities of concerned citizens, new regulations and strategies by various governments and agencies to improve water quality and to reverse storm water impacts are moving us in a positive direction. Each governmental unit plays a different role that collectively can improve and protect our waterways.

The Environmental Protection Agency (EPA)

The mission of the Environmental Protection Agency is to protect human health and the environment. The EPA develops and enforces regulations that implement environmental laws enacted by Congress.

The EPA Water Division oversees and enforces the Clean Water Act. The Clean Water Act (CWA) was passed by Congress in 1972. The CWA's authorization is to "restore and maintain the chemical, physical, and biological integrity of the Nation's waters." The greatest strength of the CWA is its acknowledgment that citizen involvement can actively counterbalance contradictory practices for clean water. President Jimmy Carter said in support of citizen involvement that "government agencies have trouble maintaining their commitment to goals unless groups who care about an issue hold the government accountable." Student groups can play a viable role advocating for clean water including water monitoring, litter clean-ups and being active in informational campaigns, to name a few!

Administration of the CWA is divided into Regions. Wisconsin is in EPA Region 5. Water Divisions are responsible for groundwater protection, safe drinking water, water enforcement and compliance, water quality, and wetlands and watersheds.

The Wisconsin legislature drafts and approves legislation for implementing CWA mandates and distributes funds to the Wisconsin Department of Natural Resources for CWA activities.

Wisconsin Department of Natural Resources

The Department of Natural Resources (DNR) plans and implements programs to ensure CWA requirements are upheld. DNR monitors and reports the progress of clean water activities. The DNR's Bureaus of Watershed Management and Fisheries Management & Habitat Protection are primarily responsible for implementing the CWA. The DNR is divided into 5 regions for watershed-based management and protection. Furthermore, the DNR grouped the 32 river basins in the state into 23 Geographical Management Units (GMU). In 2000, Wisconsin established the 2000 Water Quality Inventory Report in an effort to increase public participation in each GMU. See Resources for Students to find out how to locate your watershed-based management region, river basin, Geographical Management Unit, and watershed.

County Level Water Management

Every county is also involved in water issues. County Land and Water Conservation Departments develop Land and Water Resource Management Plans on a watershed level particularly relating to zoning and nonpoint source pollution control. These plans look for citizen input.

Cities, Villages and Towns

Additionally, cities, villages and towns are involved in water quality and storm water management. Public Works departments are responsible for management of the storm water infrastructure including drains, pipes and detention areas. As a result of new statewide storm water discharge requirements, municipalities (cities, towns, villages) must reduce suspended solids (sediment) by 20% by 2008, and 40% by 2013, for improved water quality. As a result, municipalities are developing new regulations and requirements for construction erosion control and for other water pollution sources. These regulations for storm water require municipalities to implement outreach and education to increase awareness of storm water impacts and encourage the public to take actions that reduce storm water impacts. This storm water curriculum unit is a product of the Dane County permitted municipalities' education effort. The following section describes approaches to help reduce storm water impacts on Wisconsin waters.

What Can Citizens Do about Storm Water in Our Watershed?
Managing storm water by applying "Best Management Practices" (BMPs) is critically important in both urban and rural areas. BMPs are methods and techniques designed to reduce or eliminate sources of water pollution. A significant solution is keeping rain water close to where it falls by stopping the water from entering the storm water system in the first place. The water that does enter storm drains should only be rain without pollutants. The best way to reduce storm water pollution is to involve the watershed community—students, homeowners, business owners, farmers and local government. Everyone needs to take an active role to reduce storm water impacts, improve water quality and promote a healthy watershed. Citizens of all ages can make a difference by implementing storm water management practices best suited to their own circumstances. The cumulative effect of each citizen's action is key to storm water management.

Each community member has a choice to make a positive difference in the watershed. There are a variety of BMPs to help guide those choices, for instance:

> **Homeowners** can reduce the impacts of storm water runoff on their properties by directing water to pervious surfaces, infiltrating water by building rain gardens, using rain barrels to store rain water, and reducing chemical and nutrient runoff by practicing low-input lawn and yard care.
>
> **Schools** can reduce the impacts of storm water runoff by directing water to pervious surfaces, by infiltrating water from roofs and parking lots in rain gardens and by practicing low-input lawn care. Teaching about storm water impacts and offering students service-learning project opportunities for reducing those impacts can also have a positive effect.
>
> **Businesses** can reduce runoff and pollutant inputs by infiltrating and filtering runoff from impervious surfaces such as parking lots and roofs, re-routing clean water so it doesn't cross dirty parking lots, re-designing parking lots, using porous paving materials when feasible, practicing low-input lawn care, and managing trash and other materials so that they do not end up in the storm water.
>
> **Local Government** can implement Best Management Practices on its own properties, redirect storm water from streets to large-scale rain gardens (bioretention basins) or swales (ditches that hold and infiltrate water), implement effective street sweeping and reduce use of road salt. Additionally, local governments can encourage residents to utilize Best Management Practices dealing with storm water through incentives, local codes and regulations.

The watershed community as a whole is able to support these local efforts through service groups, clubs, and watershed organizations. Community activities include: how-to education classes, community festivals, fundraising for community-wide planting projects and forming a watershed watch program, among others. More ideas can be found at www.myfairlakes.com.

The following table indicates which storm water actions are relevant for each watershed resident. Positive effects are categorized as "1" - reducing runoff through infiltration; "2" - improving water quality through reduction of pollutants and sediment; "3" - reducing water usage and ground water demand.

Watershed Actions Table

Actions	Effect	Schools	Homeowners	Businesses	Local Governments
1. Increasing Infiltration					
Disconnect Downspouts	1, 2	X	X	X	X
Rain Gardens	1, 2	X	X	X	X
Rain Barrels	1	X	X		X
2. Reducing Impervious Surfaces					
Native Landscaping	1,2,3	X	X	X	X
Porous Pavement and Pavers	1,2	X	X	X	X
Parking Lot Re-design	1,2	X		X	X
Street Re-design	1,2				X
Green Roofs	1,2	X		X	X
3. Improving Water Quality					
Yard Care	1,2,3	X	X	X	X
Vehicle Maintenance	2	X	X	X	X
4. Conserving Water					
Water Saving Devices and Strategies	3	X	X	X	X

The strategies and techniques listed in the table are described below. These actions are divided into 1) increasing infiltration, 2) reducing impervious surfaces, 3) improving water quality, and 4) conserving water.

1. Increasing Infiltration

Disconnect Downspouts (roof gutters)

When a downspout drains directly to impervious surfaces such as sidewalks, driveways, and parking areas, the untreated runoff flows directly to a storm drain. The simple act of redirecting the downspout to a pervious, vegetated area such as lawn or landscaped area allows some of the water to be absorbed into the ground before entering a storm drain. Generally, rainwater must flow over at least 20 feet of pervious surface such as a lawn to absorb water.

Figure 9: Downspout directed toward a rain garden. Source UW Extension.

Figure 10: First year rain garden planting at Prairie View Elementary School, Oregon, WI. The rain garden was planted by students, their teachers, and parents. A third year photo is on cover of this Storm Water Guide. Source Cheryl Bauer-Armstrong.

This action is a simple, inexpensive first step for residents whose downspouts are directed to impervious surfaces. Directing water into a rain garden is more effective, especially in small spaces. The next step to effectively keep rainwater on-site is building a rain garden and/or installing rain barrels as described below.

Building Rain Gardens

Rain gardens are gardens designed to manage storm water allowing natural functions of infiltration and evaporation contributing to a natural hydrologic cycle through. Rain gardens are constructed shallow depressions designed to collect water primarily from downspouts. Storm water from driveways, streets and parking areas can also be redirected to rain gardens. The concept is to let plants, bacteria and soils clean and temporarily hold the water as it soaks into the ground close to where the rain falls. Rain gardens offer a host of benefits; they trap and break down pollutants, recharge ground water, restore natural habitat, attract wildlife, add aesthetic beauty, and improve the soil.

Rain Barrels

On lots where space is greatly limited, rain barrels can collect rooftop runoff from downspouts. The harvested rainwater can be used for irrigation of lawns and gardens, car washing, and window cleaning. Rain barrels have faucets so the storm water can be used to water plants or to slowly empty and infiltrate the water after a storm event. Containers can be made of fiberglass, concrete or metal. Rain barrels should be opaque, since sunlight will promote the growth of algae. They need to be kept covered to reduce mosquitoes and prevent access to small animals or children. Rain barrels are not suitable for

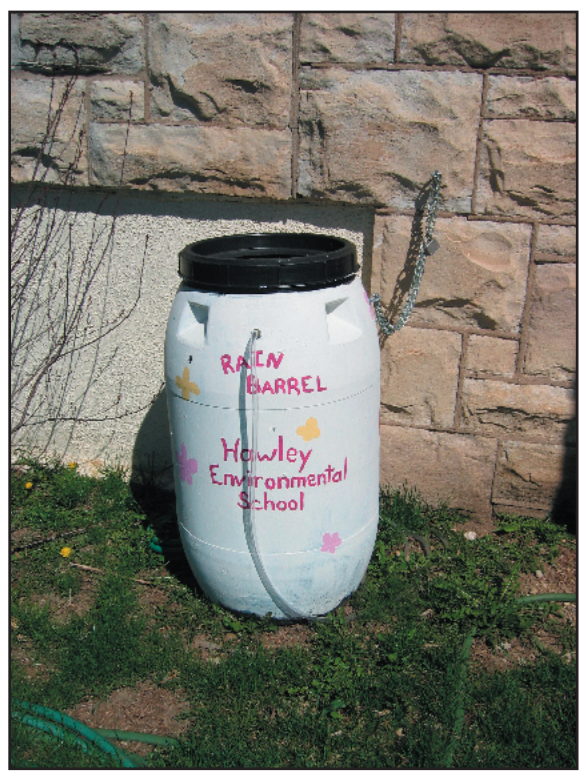


Figure 11: Rain barrels located at downspouts can catch water and slowly release it or save water for irrigation. Students at Hawley Environmental School, Milwaukee, WI, built this rain barrel. Source Cheryl Bauer-Armstrong.

use during the winter and must be cleaned out once a year to reduce clogging from leaves and debris.

Several rain barrels are available commercially through the World-wide Web or can be built. Barrel size ranges from 50 to 250 gallons and costs range form $25 to $150. (Check www.myfairlakes.com for sources.) Primary benefits of rain barrels are to reduce and slow runoff. Secondary benefits include lessening demand on city water supplies. Collecting rooftop water can lower the peak demand for water during the hot summer months and perhaps lower water utility bills when the rain is used for watering. Residential irrigation accounts for 40% of domestic water use (Center for Watershed Protection).

2. Reducing Impervious Surfaces

An ideal watershed action is reducing impervious cover by converting it to pervious cover. Reduction of impervious cover in any and all ways directly reduces the volume of storm water runoff, reduces peak rates and reduces pollutants generated. Examples described below include use of native gardens, reducing pavement, using permeable/porous pavements, and creating green roofs.

Native Landscaping

The practice of converting turf to a more natural landscape with native plant species such as wildflowers, grasses, shrubs and trees helps to subtly yet effectively increase infiltration and improve water quality. Native vegetation has deep root systems that directs more rainwater into the ground than typical turf grass. Additionally, native vegetation reduces the need for fertilizers, herbicides and pesticides. This reduces risk for adults, children and pets from coming into contact with chemicals, and reduces the chance of these chemicals being transported in storm water. Furthermore, a native landscape does not require irrigation, reducing the stress on water supplies during the peak demands of summer.

Figure 12: The sign reads, " Former asphalt driveway now has crushed granite with a brick border to reduce runoff and costs." The homeowner participated in a garden tour highlighting water-friendly landscapes. Source Cheryl Bauer-Armstrong.

The cumulative effects of native landscapes are difficult to measure, but clear benefits are provided – natural hydrologic conditions are returned to the site, native habitat is expanded, invasive plant species are restrained, and soil erosion is prevented. Lorrie Otto, founder of Wild Ones, Natural Landscapers Ltd.; is frequently quoted for exclaiming the benefits to a natural landscape. She eloquently says, "If suburbia were landscaped with meadows, prairies, thickets and forests, or with combinations of these, then the water would sparkle, fish would be good to eat again, birds would sing and human spirits would soar."

Reducing Pavement as an Impervious Surface
Pavement accounts for two thirds of urban surface area and is the primary source of petroleum pollution.

Porous Pavement
One way to reverse the effects of pavement is to use permeable pavement, where feasible, such as for driveways and parking areas. Porous pavement can be made up of concrete or asphalt and is mixed with angular crushed stone. The stone is carefully screened to remove all fine particles. If these particles are not removed, they fill the gaps between the stones and impede permeability. The cost of porous pavement is more than traditional pavement, but the elimination of piping and storm drains reduces the overall cost. Benefits for pollutant removal are high if the pavement is working properly. If successful, porous pavements remove 80 to 100% of pollutants (Metropolitan Washington Council of Governments, 1992).

Bricks, Pavers and Turf Pavers
Another option to reduce impervious surfaces is replacing traditional concrete and asphalt with bricks or pavers. Pavers are similar to bricks but made with cement rather than clay. Joints between pavers absorb water during storm events at a rate of four inches per hour, which is sufficient for even intense storms. Turf pavers have holes that can be filled with soil and grass. These options are successful alternatives for homeowner’s driveways, walkways and patios.

Figure 13: Green roof planting at Urban Ecology Center, MIlwaukee, WI. Source Cheryl Bauer-Armstrong.

Green Roofs
A green roof is a roof covered with plants; they significantly reduce storm water runoff. Seventy-five percent of storm water can be retained in the plants and soil layer. The remaining twenty-five percent is runoff, which is slowly released after peak flow and therefore reduces the initial surge of floodwaters and stress on storm water systems. Green roofs can be built on schools, business and manufacturing buildings, shopping malls, apartment buildings and other buildings with wide roof areas. Construction of green roofs is available through the EPA’s Clean Water Act section 319.

In addition to the benefit of storm water management, green roofs improve air quality, reduce the heat island effect in urban environments, improve the building's energy efficiency, and extend the lifespan of a roof.

3. Improving Water Quality

Yard Care

Yard care practices from overuse of lawn chemicals, to leaving leaf litter in the gutters, to not picking up after pets, have a negative impact on water quality. Nutrients such as phosphorus and nitrogen in lawn chemicals and organic matter causes an explosion of aquatic lake weeds and algae growth, which chokes the waters. Fish and other aquatic life are deprived of oxygen; and non-native, invasive species flourish with nutrient overloads. Beaches are temporally closed due to unsafe levels of bacteria.

Nitrogen and phosphorus levels from lawn runoff are 2 – 10 times higher than any other urban storm water source (Bannerman, 1993). Typically 50 – 70% of all fertilizers are applied above recommended rates. The ideal action would be not to apply chemical fertilizers. The next best thing is to adopt more water-friendly, low-input practices for lawn care. It is possible to have a healthy, well kept lawn without compromising water quality. Suggested healthy, less harmful lawn and yard care practices follow:

1. Test soil before applying fertilizers.
2. Fertilizer use – use only when needed after testing soil for application rates. UW-Extension recommends to only fertilize right after Memorial Day and then again in early to mid-November (about two weeks after putting the lawn mower away for the year). Early spring fertilizing can lead to more polluted runoff, and the lawn doesn't really need it. If the soil is infertile, another fertilizer application can be done in late August. In Dane County, it is illegal to use fertilizer with phosphorus unless a test shows a need or when the lawn is first planted. Other strategies include not fertilizing before a rainstorm. Use a drop spreader rather than a rotary spreader to keep fertilizer directed to the lawn and not spewed over sidewalks and driveways. Use organic fertilizers such as compost, which release nutrients slowly over time.
3. Use Integrated Pest Management (IPM) to manage insect pests without relying on chemical controls. IPM minimizes environmental and human health risks through using physical, mechanical and biological controls. Techniques include trapping insects, introducing beneficial insects, using insecticidal soaps, and keeping plants healthy to prevent disease. (IPM does use limited pesticides when absolutely necessary.)
4. If hiring a lawn care company, insist the company tests the soil first, uses only the minimum amount of chemicals necessary to maintain a healthy lawn or uses alternative, organic methods.
5. Cut lawn at 2.5 to 3 inches high. Grass this height is healthier, shades weeds, and needs less water. Allow clippings to remain on the lawn to recycle nutrients and retain soil moisture. Sweep clippings off the pavement.
6. Sweep sidewalk and driveways rather than clean with a hose or blower.
7. Keep leaves out of the gutter where they can easily be transported by storm water.
8. Compost leaves to use as fertilizer or mulch.
9. Aerate your lawn for better infiltration.
10. Cover exposed bare soil areas with ground cover or mulch to reduce soil erosion.
11. Pick up and dispose of pet waste. Pet waste can be buried 5 inches deep in the soil or flushed down the toilet. Place it in garbage can, if allowed by local ordinances. Pet waste is major source of fecal coliform bacteria and pathogens in suburban watersheds.

Implementation of these practices will improve water quality through reducing phosphorus, nitrogen, pesticides, herbicides, and bacteria from entering the waterways, which in turn, will reduce harmful effects on lakes and rivers.

4. Conserving Water

One reason to promote water conservation in a watershed is that groundwater is now pumped out faster than it can be replaced. Water is consumed in homes and businesses, emptied into the sewer system as wastewater, treated and released into streams and rivers rather than infiltrating. Lawn watering and farm irrigation during summer months increases demand and further lowers groundwater levels.

Strategies to reduce water consumption include installing water saving plumbing devices, stopping leaks, replacing old toilets and washing machines, and irrigating with water collected in rain barrels. If residents irrigate with a hose, they should use a soaking hose, water before 10 AM or after 4 PM, and only when plants need water. Established, healthy lawns can survive several weeks with little or no water. They naturally go brown in the summer and will green up as soon as the weather isn't so hot and dry. Planting native species also reduces the demand on the water supply because they are adapted to natural rainfall.

How Can Students Make a Difference to Improve Water Quality?
Students can play a vital role helping to solve problems associated with storm water. There are two broad areas where students can make a significant difference.
The first part is on-the-ground, hands-on activities. Examples of some of these activities include:

- Storm drain marking (Painting messages or placing stickers near storm drains that state, "Dump No Waste – Drains to Stream")

Figure 14: Storm drain marking is one of many ways students can help to improve water quality. Source Friends of Lake Wingra, Inc.

- Re-directing downspouts from pavement to grassy areas
- Building rain gardens at school and home
- Initiating leaf composting at school and home
- Performing a watershed assessment of the community
- Building rain barrels (possible as a school or scout fundraiser)
- Volunteering to help build rain gardens at public buildings such as the library
- Stream or lake monitoring
- Helping elderly residents care for their yard
- Encouraging and helping your parents practice best management yard care
- Planting native plantings at schools, homes, and in the community

The second part is providing education and outreach in the community. Examples of some of these activities include:

- Researching a storm water or water quality issue for science fair or club project
- Writing articles for newsletters and community papers
- Creating and distributing flyers, brochures or fact sheets
- Presenting about storm water issues and solutions at garden, service and other local clubs
- Documenting newspaper and media coverage of storm water topics and discussing them in class
- Interviewing long-term residents to learn how the area and land use has changed

Can you think of other ways students can help make a difference for water quality in your local watershed? Martin Luther King, Jr. said, “The biggest threat to humanity is not the evil of the bad persons but the passivity of the good ones.” In other words, it doesn’t matter what you do to make a positive change – just do it.

Figure 15: A student from Spring Harbor Middle School researched impacts on a local spring from pumping groundwater and presented his findings at the Earth Partnership for Schools Student Research Conference at UW-Madison Arboretum. Source Bill Arthur.

Conclusion
Successful watershed changes to reduce storm water impacts require communication, involvement, partnerships and commitment by all citizens living in the watershed. Successful, sustainable watershed management that is effective today, tomorrow and 100 years from now must be wide-ranging and encourage long-term participation.

It takes time for new ideas to be accepted and implemented. It takes time to think about storm water in different terms—not as a liability that needs to be quickly channeled away, but as a valuable part of a landscape and a natural and vital process on the land. The short-term benefits of changing the dynamics of water on the landscape are reduced damage from flash floods, keeping base flows in streams, and improved water quality. The long-term benefit is a landscape that is ecologically healthy, sustainable and actually improves the quality of life.

Figures 16 and 17: One-hundred and fifty community volunteers planted a native shoreline buffer to limit geese and improve water quality at the Vilas Park lagoon, Madison, WI. Before the planting hundreds of geese mingled along the shoreline. Source Jim Lorman.

Water in a Watershed

Activity Overview: Students participate and learn about watersheds, storm water runoff and pollution by creating a watershed model.

Source: Adapted from SWEAP: Small Watershed Ecology Assessment Project, Ana Ruesink, Institute of Ecosystem Studies, PO Box R, Millbrook, NY 12545,
http://www.ecostudies.org/images/education/sweap/SWEAP.pdf
http://www.ecostudies.org/images/education/sweap/.%5CMODULE_1.pdf

Objectives: Students will
- learn a watershed (or drainage basin) is the area of land that contributes water to a stream or pond
- realize the flow of runoff and seepage in a watershed is directed by ridges – high points that separate adjacent watersheds
- know everyone lives in a watershed
- understand land use activities in a watershed can affect water quality and quantity

Subjects Covered: science, environmental science, social studies

Grades: 4 - 9

Activity Time: 25 minutes

Season: Any

Materials: Shallow basin or tub, several sheets of newspaper, white plastic garbage bag, spray bottle, food coloring, and 1 piece of paper towel

State Standards: Science: A.4.1., A.4.2., A.4.3., A.4.4., A.4.5., A.8.1.,A.8.3., A.8.6., A.8.7., C.4.1., C.4.2, C.4.4., C.4.5., C.4.6., C.4.7., C.4.8., C.8.3., C.8.4., C.8.6., E.4.8, E.8.1., F.8.8., Social Studies: A.4.1., A.4.4., A.4.6., A.4.8., A.8.5., A.8.6., A.8.8., A.8.11.

Note: See Governor's Council on Model Academic Standards. (1998). *Wisconsin's Model Academic Standards*. Madison, WI: Wisconsin Department of Public Instruction for detailed descriptions.

Background: See Background Section in *Stormwater Curriculum and Teaching Guide* for information about watersheds and how land use activities in a watershed affects water quality and quantity.

Activity Description: Create a simple watershed model by crumpling up several pieces of newspaper and placing them in the bottom of the basin. Cover the newspaper with plastic: this is the land surface. The uneven distribution of the paper should create a raised relief map with hills and valleys. Ask the students what will happen to rain falling on the land surface. Where will it go? Where will it end up? Spray water on the plastic to test their predictions. (The water will be easier to observe if you add a little food coloring.) The water will flow from the high points to low points in rivulets that represent streams and rivers and will collect in pools that represent lakes or the ocean. Explain that the area draining into each stream, river, or lake is called a watershed. Notice that every location on the plastic is part of a watershed. Use a tiny piece of paper towel soaked in food coloring to represent a source of contamination like motor oil or lawn fertilizer or a leaky septic system. (Make sure you use a different color of food dye this time.) Ask students to predict what will happen to the contamination when it rains. Place the dyed piece of paper towel on the plastic watershed model and spray to make it rain. Watch as the “pollutant” flows into a stream and then into a nearby lake or ocean. Also, notice that only one “watershed” is polluted unless the pollutant is on a divide.

Assessment:

- Define a watershed.
- Describe how the shape of land forms controls the movement of water.
- Explain how a pollutant might enter lakes and rivers in a watershed and what you would do to stop it.

Extensions:

- Students learn what local watershed they live in and continue to identify watersheds they are in until they identify the largest watershed that feeds into an ocean.
- Students research land use activities in their watershed and present findings.
- Students build a model of their own watershed.
- Students build models of the same watershed but with different land uses and amounts of impervious and pervious surfaces, and compare change in water quality and quantity.

Resources:

About WDNR’s Hydrologic Areas
http://www.dnr.state.wi.us/org/gmu/sidebar/whatis.htm#gmus

After the Storm: A video co-produced by EPA and the Weather Channel. US Environmental Protection Agency. Washington, D.C. Publication # EPA 840-V-04-001

Branching Out! *Project Wet: Curriculum and Activity Guide.* The Water Course. Bozeman, Montana: p.129-32.

Holling, Clancy. 1941. *Paddle to the Sea*. Houghton Mifflin Company. Boston, MA.

Locker, Thomas. *Where the River Begins.* Dial Books. New York, NY.

Surf Your Watershed, US Environmental Protection Agency. www.epa.gov/surf

Watershed in a Box, Make Waves for Action, Wisconsin DNR and UW Extension Environmental Resources Center. http://clean-ater.uwex.edu/wav/otherwav/winbox.pdf

Watershed Planning Game, Bell Museum of Natural History
http://www.bellmuseum.org/ecogames.html

Follow the Drop

Activity Overview: Students observe and collect information about water runoff on their school property.

Objectives: Students will
- practice observation and investigative skills
- survey and collect information about their school site
- calculate the volume of rain water falling and forming runoff on their school grounds
- Use critical thinking skills to develop ideas for storm water management on their school grounds

Subjects Covered: science, math

Grades: 4 - 12

Activity Time: 2 hours: 1 hour on the school grounds, 1 hour in the classroom

Season: Any, preferably spring or fall

Materials: clipboards, pencils (or colored pencils), "Follow the Drop" handout, map of schoolyard showing property lines and building locations (and/or graph paper), average annual rainfall data obtained from the weather bureau, local newspapers or TV weather newscaster, etc.

State Standards: Math: A.4.1, A.4.2, A.4.4, A.8.1, A.8.3, A.12.1, B.8.5, C.4.4C.12.1, D.4.2D.12.2; Science: F.8.9, F, F.4.4.12.7, F.12.8

Note: See Governor's Council on Model Academic Standards. (1998). *Wisconsin's Model Academic Standards*. Madison, WI: Wisconsin Department of Public Instruction for detailed descriptions.

Background: Water moving over the landscape in a large city, a medium-sized subdivision or single school yard after a rain event will flow basically the same, only the scales are different. A larger volume of water moves across the landscape in a large city compared to a small school yard. Nevertheless, in either case, water may flow in sheets, collect in channels, drain into pipes, accumulate in puddles or soak into the ground during a rain storm. Rain water will eventually drain to a river, a lake or to ground water. To have a life sustaining, healthy watershed with clean water, each site, whether large or small, requires thoughtful storm water management planning. One of the best ways to ensure clean water is to control runoff near its source and to start management at the point where water first contacts the earth. Keeping water out of storm sewer systems lessens erosion and sediment carried into lakes and rivers, reduces pollutants carried by moving water, and decreases chances of flooding. See Background Section of this *Storm Water Curriculum and Teaching Guide* for more information.

Activity Description: The purpose of this activity is to promote students' understanding of the patterns of water movement on their school grounds and the larger watershed. It will provide a first hand experience that will lead them to critically think about issues related to storm water and develop ideas to manage storm water on their school grounds to support a healthy watershed. Information collected can be used to determine what steps can be taken to improve water quality in the watershed and reduce runoff leaving the school.

Pre-activity Preparations:

- Make a copy of an existing school map showing the location of buildings, drives, and property lines. Locate north and indicate a scale on the map.
- If desired, divide the map into sections. Assign a section to each student team. The team will locate and record all features described below that are inside their section. Each section can be reassembled to form a composite map.
- Another option is to give every team one complete map and assign one or more of the features described below to each team. Each team will locate only the assigned feature(s) such as the location of downspouts on the school building.

Directions: This activity involves three steps. First students will survey the school grounds, identify how water moves over the land, and mark this information on a map. Second, they will take measurements of designated areas on the school grounds to calculate the amount of annual rain and runoff produced in that area. Third, students will begin to identify locations for reducing runoff on the school grounds. These three steps are described below in more detail.

Step 1: Identify Water Patterns.
Have students form teams, and go outside to identify the patterns of water movement. Locate the following features on your map.

- Locate high and low points. Indicate high points with a "+" sign and low points with a "-" sign.
- Locate hard surfaces (impervious) such as parking lots and sidewalks, where water runs off. Next locate porous surfaces (pervious) such as planted beds or lawn areas where water may soak in or infiltrate the ground. If desired, differentiate lawn verses garden. Color code these areas.
- Identify patterns in water movement such as where water might flow in sheets or in gullies or channels. Draw arrows to show direction of movement.
- Locate storm drains on school property. Write "D" on the map to represent storm drains.
- Locate where water enters the school grounds from hillsides, streets or other locations. Show with arrows.
- Identify where water exits the school grounds such as through ditches or off school parking lots. Show with arrows.
- Locate places where water puddles. Hint: areas that puddle may have different plants than the surrounding area; the soil may always be wet or hard and cracked when dry.

- Identify where water spills from one surface to another. For example, if water is moving from a hard, impervious surface like a sidewalk to a pervious, vegetated area or vice versa.
- Determine where the water goes that falls on the roof. Locate any downspouts around the buildings. Mark an “X” where you see a downspout.

Step 2: Measure Areas for Rain and Runoff Calculations.
Select areas to measure in order to calculate for rain and runoff statistics. Possible areas to measure include the school roof, parking lots, and playing fields or play areas. You may also consider measuring pervious areas compared to impervious areas. If your base map is drawn to scale, these measurements may be made in the classroom using rulers or a grid system. Use measuring tapes or paces to make on-the-ground measurements.

Calculations:

1. Calculate the area of your selected site (roof, parking lot, play area, etc.) by multiplying length by width to equal area in square feet.

   Example: 30 feet X 50 feet = 1,500 square feet area

Calculate Area	30 ft.	X	50 ft.	= 1,500 sq. ft.

2. Multiply average annual rainfall data by area to determine the volume of rainfall falling on a particular site. In this example, the average annual rainfall data is 30 inches per year.

   a) Convert average annual rainfall data from inches to feet.

   Example: 30 inches ÷ 12 inches = 2.5 feet.

Convert annual rainfall from inches to feet	30 in.	÷	12 in.	= 2.5 feet

   b) Multiply average annual rainfall data by area.

   Example: 2.5 feet X 1,500 square feet = 3750 cubic feet for annual rainfall.

3. Calculate how much of the rain becomes surface runoff on the school grounds.

Determine rainfall on area	2.5 ft	X	1,500 sq. ft.	= 3750 cu. ft.

   c) If rain is falling on hard surfaces such as a parking lot, all or 100% is runoff.

   Example: 3750 X 1.00 = 3750 cubic feet is surface runoff.

Calculate surface runoff from a parking lot	3750 cu. ft.	X	1	= 3750 cu. ft.

d) If rain is falling on a lawn, about 60% (approximate) is runoff. Runoff from lawns can be variable depending upon soil type, condition of the lawn, and topography.

Example: 3750 X .60 = 2250 cubic feet is surface runoff. (1482 cubic feet infiltrates)

Calculate surface runoff from a lawn	3750 cu. ft.	X	.60	= 2250 cu. ft.

e) If water runs into a rain garden (collects and infiltrates rain water), calculate no or 0% runoff.

Example: 3750 X .00 = 0 cubic feet is surface runoff.

Calculate surface runoff from a rain garden	3750 cu. ft.	X	.00	= 0 cu. ft.

Step 3: Discuss Observations and Results of Calculations.
As a class, share your findings based on observations and calculations on the school grounds. Discuss the big picture of water movement by identifying unique characteristics observed, possible problem areas, etc. Talk about ways the school can reduce runoff on school grounds. Identify likely areas to create a rain garden to collect and infiltrate water.

Assessments:
- Describe the topography of your schoolyard and how it affects the flow of water during a heavy rainfall.
- Tell a story about a rain drop falling on the school grounds. Describe its journey as it moves on the school property.
- List positive aspects and things that could change on the school grounds to develop a healthy watershed.
- Have students give oral reports on their findings and suggestions for storm water management on their school grounds.

Extensions:
- Go outside when it is raining, and observe storm water runoff in action. (See Rainy-Day Hike. *Project Wet: Curriculum and Activity Guide*. Bozeman, Montana. Pages 186 – 190.)
- Pour a bucket of water or balls on the ground to get a sense of how water moves. Students may make predictions before pouring the contents of the bucket.
- Identify the watershed (s) the school is located in, and then map what route the school's runoff will take to the nearest body of water.
- Calculate, using the activity formulas, the amount of water falling on the school grounds after a single rain event. Use a rain gauge to obtain rainfall quantity.
- Observe what the rain water runoff is picking up along its route – sediment, trash, oil and gas, etc.

- Determine the number of showers that can be taken with the calculated results. A five minute shower uses 25 gallons of water. 1 cubic foot = 7.2827 gallons.

Example: 3750 cubic feet X 7.2827 = 27410.125 gallons
27410.125 gallons ÷ 25 gallons = 1093 showers

Convert cubic feet to gallons	3750 cu. ft.	X	7.2827	= 27410.125 gallons
Calculate possible number of showers	27410.125	÷	25	= 1093 showers

Resources:
Leopold, Luna B. 1974. *Water: A Primer*. W.H. Freeman & Co. San Francisco, CA.

Where Does Water Run Off after School? *Project WILD. Western Regional Environmental Education Council. Bethesda, MD.*

Sample Follow the Drop Calculation Form

Calculate areas				
Site	Width	X	Length	Area
Total area	feet	X	feet	square feet
Parking lot/roof	feet	X	feet	square feet
Lawn	feet	X	feet	square feet
Rain garden	feet	X	feet	square feet
Other	feet	X	feet	square feet
Convert annual rainfall from inches to feet				
	Annual rainfall			Annual rainfall in feet
	inches	÷	12 inches	feet
Determine rainfall on area				
Site	Annual rainfall in feet		Area	Total rainfall
Total area	feet	X	square feet	cubic feet
Parking lot/roof	feet	X	square feet	cubic feet
Lawn	feet	X	square feet	cubic feet
Rain garden	feet	X	square feet	cubic feet
Other	feet	X	square feet	cubic feet
Calculate surface runoff				
Site	Total rainfall		% runoff calculator	Surface runoff
Parking lot/roof	cubic feet	X	1	cubic feet
Lawn	cubic feet	X	.60	cubic feet
Rain garden	cubic feet	X	0	cubic feet
Other	cubic feet	X	1 - 0	cubic feet
Total surface runoff	**Add all surface runoffs from above.**			**cubic feet**

"Water" You Doing with Hydrology?
(A Water Inventory Summary)

Activity	1 Score	2 Score	3 Score	Totals
Automobile Wastes				
Car Washing				
Driveways, Sidewalks, and Parking Areas				
Roof Drainage from Downspouts				
Conditions of Storm Drains				
Landscaping				
Handling and Use of Outdoor Chemicals				
Pet and Animal Waste				
Outdoor Water Conservation				
Yard Waste				
Household Water System				
Household Water Conservation				
Totals				

Total Score: _____________ Average Score: ________________

Highest Ranked Activity: _____________ Lowest Ranked Activity: _______________

"Water" You Doing with Hydrology? (A Water Inventory)

Activity Overview: Students assess the potential risks to water from storm water runoff coming off their school or home properties. Additionally, students evaluate water usage at home or school.

Source: Adapted from Home*A*Syst storm water management assessments in *Home*A*Syst.* Developed by National Farm*A*Syst/Home*A*Syst program in Cooperation with the Northeast Regional Agricultural Engineering Services (NRAES). Ithaca, NY.

Objectives: Students will:

- Understand how activities at home and school affect surface and ground water in their local watershed
- Examine and evaluate possible impacts on the local environment
- Make decisions on what impacts may be of greatest concern in their community
- Develop knowledge and skills to identify best possible solutions to the impacts

Subjects Covered: science, environmental science, health, social studies

Grades: 4 through 12

Activity Time: In class: 10 minutes introduction, 30 minutes analysis and discussion of options. Homework: 30 minutes

Season: Any, Fall and Spring are best

Materials: Student inventory sheets, inventory summary page

State Standards: Science: A.4.1., A.4.2., A.4.3., A.4.4., A.4.5., A.8.1.,A.8.3., A.8.6., A.8.7., A.12.1., C.4.1., C.4.2, C.4.4., C.4.5., C.4.6., C.4.7., C.4.8., C.8.3., C.8.4., C.8.6., C.12.3., C.12.4., E.4.8, E.8.1., F.8.8., F.12.8. Social Studies: A..4.1., A.4.4., A..4.6., A.4.8., A.8.5., A.8.6., A.8.8., A.8.11.,A.12.4, A.12.6., A.12.12., E.4.1. E.8.1., E.8.4., E.12.4.

Note: See Governor's Council on Model Academic Standards. (1998). *Wisconsin's Model Academic Standards*. Madison, WI: Wisconsin Department of Public Instruction for detailed descriptions.

Activity Description: One way to learn about the health of local watersheds is to take an inventory of the existing practices community members do that have an impact on water quality and groundwater supply. In this activity, students will assess potential storm water pollution sources and current water conservation habits in the community. Examples of factors they will evaluate include automobile and yard care practices, downspout connections, amount of impervious surface, and water usage. They will implement the inventory where they live. The results from their small sample will give them a general picture of potential watershed concerns in the community. They can use this information to develop outreach materials that will educate their community about the health of their watershed and how citizens can actively help make improvements.

Activity Directions:

1. Hand out inventory sheets, and review the process for filling out the forms.
2. Review information collected when students return with completed inventory sheets. Fill out the class summary sheet to calculate the class' findings. Mark each student's score for the individual problem (i.e., if Johnny circled a three for "Automobile Wastes," then make three tic/tally marks in the column next to the listed problem and continue for each student). At the end add up each mark, and write the sum in the last column of each row. This will inform students which problems were the most common or troublesome for the class sample. Then add this last column's numbers and write the sum in the row below the last problem. This final score is the class' overall score. Suggestion: If students multiply twelve by the number of students there are, this will give them the best possible score that could be achieved. Then multiply thirty-six by the number of students to give the worst possible score. Have the students see where their class' score is relative to this range of numbers in order to give them a perspective on how well the sites rate as a whole.
3. Next, have students answer the summary questions, and have a brief discussion based on the question sheet. Also discuss the students' experiences doing this activity; what they learned, what was difficult, if they see any flaws in the inventory, or possible solutions to the class' highest scoring problems.
4. Use the data collected as a source for outreach material development in the Earth Partnership for Schools activity: *Outreach Materials: Creating Solutions to Storm Water Pollution.* The creation of outreach materials offers students a service-learning opportunity to address the class' areas of watershed concerns to the larger community.

Assessment:

- Explain how activities at home affect surface and ground water in their local watershed.
- What storm water impacts are the greatest concern in the community and why?
- Identify three activities community residents can implement to improve water quality and/or groundwater supplies.

Resources:

Andrews, Elaine. 1996. *Give Water A Hand Leader Guidebook.* UWEX Environmental Resources Center. Madison, WI.

Eagan, David (Ed.). 1997. *Home*A*Syst.* National Farm*A*Syst/Home*A*Syst program in Cooperation with the Northeast Regional Agricultural Engineering Services (NRAES). Ithaca, NY.

"Water" You Doing with Hydrology? (A Water Inventory)

Name: ______________________________________

Questions to think about:

1. Add up all the numbers you circled and compare that number to the scoring key.
   ______ Score How did you and your family do?

2. Add up all your classmates' numbers. How did you do as a class?

   ____ Total ÷ ____ Number of students = _____ Score

3. Were you surprised by either of the results? Why or why not?

4. What did you learn by doing this activity?

5. What are some ideas you have about how to improve your score? What are the easiest/hardest problems to change?

6. Which sections had the highest scores in the class? Why?

7. What can your class do as a whole to improve the overall score?

8. Based on your class findings, what kind of outreach project could you create to inform the public about how your community might improve water quality in the watershed?

Name: ________________________________ Date: _________________________

☐ Home ☐ School ☐ Other: ____

Directions: Read through each section of the inventory, and circle the number that best describes your observations. Ask your parents/guardians (or school building maintenance manager) if you are unsure about an answer or where an item is located. Then complete the following questions.

Activity	1 Score	2 Score	3 Score
Outdoor Inventory:			
Automobile Wastes	**1** Oil drips, spills and leaks are cleaned up. Greasy car parts and vehicle liquid wastes are out of reach of storm water runoff.	**2** Oils drips, spills and leaks are not cleaned up. Car parts are left on unpaved areas outside.	**3** Used oil, antifreeze, washer fluid and other wastes are dumped down the storm sewer, in a ditch, or on the ground.
Car Washing	**1** Cars and trucks are washed at car washes or spray booths.	**2** Cars and trucks are washed on the lawn or gravel drive.	**3** Cars and trucks are washed on driveways, streets or other paved surfaces.
Driveways, Sidewalks, and Parking Areas	**1** All driveways and sidewalks are gravel or another porous material such as bricks.	**2** Some of the driveways and/or sidewalks are gravel or another porous material.	**3** Driveways and sidewalks are asphalt, concrete or other non-porous material.
Roof Drainage from Downspouts	**1** Downspouts are directed to lawn or vegetation.	**2** Some of the downspouts are directed to lawn or vegetation and others are directed to paved surfaces.	**3** Downspouts are directed to hard paved surfaces, or downspouts are directly connected to storm drains.

Activity	1 Score	2 Score	3 Score
Condition of Storm Drains (if within sight)	**1** Drains are clear of trash, leaves, etc., and/or the storm drain is stenciled.	**2** Trash and leaves are in the curb near the drain.	**3** Drains are covered with trash and leaves.
Landscaping	**1** Most of the yard is planted with native plants that are drought tolerant and absorb rain.	**2** Most of the yard is in turf grass.	**3** There are areas of exposed bare soil.
Handling and Use of Outdoor Chemicals (fertilizers, pesticides, cleaners, etc.)	**1** Spills are cleaned up, especially on paved surfaces. Minimum amounts of chemicals are applied according to instructions. Application is delayed to avoid rain.	**2** Applications are not delayed to avoid rain.	**3** Spills are not cleaned up. Products are used in higher amounts than recommended by the label.
Pet and Animal Waste	**1** Pet wastes are flushed down the toilet; buried away from gardens, wells, ditches or where children play; or wrapped and placed in the garbage for disposal.	**2** Wastes are left to decompose on grass or soil, and scattered over a wide area.	**3** Wastes are left on paved surfaces, concentrated in a pen or yard area, or dumped down storm drains or in ditches.
Outdoor Water Conservation	**1** Collect water in a rain barrel or use a rain gauge to tell you when you need to water the lawn (before 10 a.m. or after 4 p.m.	**2** Water when the lawn looks dry.	**3** Water the lawn whether it looks like it needs it or not.

Activity	1 Score	2 Score	3 Score
Yard Waste (grass clippings, leaf litter, pulled weeds, etc.)	**1** Grass clippings, leaves, etc., are swept off paved surfaces and into lawns away from storm water flow routes. Leaves and other yard wastes are composted.	**2** Grass clippings, leaves, etc., are swept off paved surfaces. Leaves and other yard wastes are <u>not</u> composted.	**3** Wastes are left on driveways, streets, and other paved surfaces where they can be carried off by storm water.
Indoor Inventory:			
Household Water System	**1** Do not have leaks or breakages in pipes, faucets, toilets or shower heads. Fix leaks and breakages immediately.	**2** Do not currently have leaks or breakages, but do not always fix them immediately.	**3** Currently have leaks and breakages in need of repair.
Household Water Conservation	**1** Turn the water off while brushing your teeth. Turn off rinse water while washing the dishes. Dishwashers and washing machines are completely full when in use. The shower heads and toilets have water savers.	**2** Sometimes turn off the water during these activities. Do not have water savers.	**3** Always run the water during these activities. Do not have any water savers.
Totals			

Scoring Key:
12-18 You’re doing great things for the environment. Keep up the good work!
19-26 Just a few things to change, but you’re on the right track.
27-36 You’ve got work to do, but you know what needs to be done.

Grand Total

Outreach Materials: Creating Solutions to Storm Water Pollution

Activity Overview: Students write and develop outreach materials such as a brochure, fact sheet, article or poster identifying a storm water problem in their community and suggesting a solution for community members to address the problem.

Objectives: Students will:
- Identify storm water problems and explain why they need to be repaired
- Learn how to develop effective outreach materials
- Practice presentation skills
- Participate in a service-learning project

Subjects Covered: language arts, science, environmental science, social studies

Grades: 4 -12

Activity Time: In class: 10 minutes introduction, 50 student presentations

Season: Any

Materials: Class statistics from Storm Water Inventory, access to information about storm water problems and solutions, card stock, poster board, access to a computer and printer, and other design materials, markers, pens and pencils, clip art, pictures, scrap booking materials, etc.

State Standards: Language Arts: A.4.2., A.4.3., A.4.4., A.8.2., A.8.3., A.8.4., A.12.2., A.12.3., A.12.4., B.4.1., B.4.2., B.4.3., B.8.1., B.8.2., B.8.3., B.12.1., B.12.2., B.12.3., C.4.1., C.4.2., C.4.3., C.8.1., C.8.2., C.8.3., C.12.1., C.12.2., C.12.3., E.4.1., E.4.3., E.4.5., E.8.1., E.8.3., E.8.5., E.12.1., E.12.3., E.12.5., F.4.1, F.8.1, F.12.1. Science: A.4.1., A.4.2., A.4.3., A.4.4., A.4.5., A.8.1.,A.8.3., A.8.6., A.8.7., A.12.1., C.4.1., C.4.2, C.4.4., C.4.5., C.4.6., C.4.7., C.4.8., C.8.3., C.8.4., C.8.6., C.12.3., C.12.4., E.4.8, E.8.1., F.8.8., F.12.8. Social Studies: A..4.1., A.4.4., A..4.6., A.4.8., A.8.5., A.8.6., A.8.8., A.8.11., A.12.4, A.12.6., A.12.12., E.4.1. E.8.1., E.8.4., E.12.4.

Note: See Governor's Council on Model Academic Standards. (1998). *Wisconsin's Model Academic Standards*. Madison, WI: Wisconsin Department of Public Instruction for detailed descriptions.

Background: Sometimes visual observations such as green, murky lakes will point out water-related challenges in a local watershed. Observations combined with statistical data can be a powerful tool for identifying specific problems, such as the overuse of fertilizer, which often causes pea soup-colored lakes. The Earth Partnership for Schools "Water" You Doing with Hydrology? (A Water Inventory) may bring some of the local watershed problems to the forefront. This data can be used in public outreach to help the community understand their local watershed issues along with offering practical solutions such as how to properly apply fertilizers. See Background Section of the *Storm Water Curriculum and Teaching Guide,* which discusses many of the impacts and answers about storm water and unsustainable water usage.

Improvement through change happens when the community becomes aware of and understands the issues, and acquires knowledge to take helpful action. Developing educational outreach materials can be a powerful way to inform and advise local citizens. Outreach efforts do produce change. A prime example is the widespread practice of recycling. Outreach concerning water can have the same success.

What types of solutions are possible to share with the community through outreach materials? Suggesting Best Management Practices (BMPs) and water conservation measures is a good place to start. (BMPs are methods and techniques designed to reduce or eliminate sources of water pollution.) Implementing BMPs and water conservation at homes and businesses will address many of the identified impacts. Often BMPs are feasible and don't require significant behavior changes. Each citizen of all ages can implement Best Management Practices and water conservation best suited to their own circumstances. The cumulative effect of each citizen's action is the key.

BMP's are described in the Background Section of the *Storm Water Curriculum and Teaching Guide,* and available resources are listed in Student Resources.

Resources about creating outreach materials are listed in the resource section of this activity.

Brochure created by Dane County Lakes and Watershed Commission

Activity Directions:

Directions begin on the following page. If preferred, use the directions as a student handout.

Outreach Materials: Creating Solutions to Storm Water Pollution

Your assignment is to create an attractive and persuasive outreach product that will inform the community about possible common and/or troublesome storm water impacts or water conservation issues in the local watershed and to offer realistic solutions. Your project will help the community to learn how to become good stewards in the watershed. Your efforts will make a difference in helping to promote a healthy place to live for you, your family, your friends and the plants and animals living in your watershed. Follow the four steps below to develop successful a outreach product.

1. Form teams and select and research storm water issues and solutions.
You identified common or troublesome storm water impacts in your community through the Water Inventory. Now you will develop outreach materials to share with the community about what you learned and how the community can get involved to help solve storm water related problems. You or your team will choose and research information about a specific impact and solution that community members can implement. Review your class notes, complete research on the internet or in the library, and use other classroom resources such as the materials listed in the Student Resource section of this storm water unit for more information.

2. Develop outreach materials.
After you've completed your research, decide what format you will use to present or display this information. There are several options including making a brochure or informational pamphlet, creating a poster board display, writing an article for the school or community newspaper or newsletter, developing a Web page on the school web site, doing a radio or television news broadcast, or making a video. Next, decide how you will distribute or present your outreach material to the community. Things to consider when deciding on an outreach approach include your time frame, the audience(s) you want to reach, the message you intend to send, and financial resources available (if any).

While creating your outreach materials, you may find the following guidelines helpful.

- Decide who your target audience is and how best to get them engaged. Questions to think about include:
  - Who is my audience? – homeowners, businesses, students, pet owners, gardeners…
  - What does my audience already know about the issue, if anything?
  - Why should my audience care, or how does it affect them?
  - What information will be interesting or useful to my audience?
  - What solutions are feasible to implement for my target audience?
- Have a clear plan of what you want the outreach material to look like before you begin. Consider availability of time and materials, organization, and aesthetics. Materials will be different for a display at a community library compared to a door hanger at an individual home or materials developed for a community or PTO/PTA meeting.
- Make it user-friendly. The material should be easy to read and follow, as well as neat, eye-catching and informational.

- Make sure your message is clear and direct.
- Pay attention to correct grammar and punctuation.
- Ensure the information you provide is accurate and based on sound data and educational sources.

Next check your information to make sure it includes these key components –

- a description of the problem
- how it affects the community with examples that relate to your target audience
- how you recognized this was a problem (i.e., the Water Inventory)
- what is or is not currently being done about the problem
- and what your audience can do to solve the problem

You may also list resources that your audience can use to seek further information. This information should be organized logically and interestingly for the audience.

3. Present and distribute outreach materials.
After your outreach materials are developed, present your project to the class. The presenters and peers may use the following rubric to constructively critique the presentations and outreach materials designed. This is good practice if you will be presenting to a larger audience at a later date. Constructive feedback can also improve the quality of the final product.

Share your information with the community using your chosen strategy for outreach. Good work! You have made a difference helping to keep your watershed and community healthy.

Rubric for an Outreach Product (for individual or team)

	Not so hot	**Getting warmer**	**Hot!**
Audience	It is not clear who my/our audience is or what they are asked to do.	My/our audience is identified; but the information is not useful to my/our audience.	My/our audience is identified and the information applies directly to their situation.
User-friendly	My/our materials are messy and difficult to read.	My/our materials help explain the issue and solution but include too many points.	My/our materials are eye-catching and help make my issue and solution clear to the audience.
Message	The message is long, wordy and confusing.	The message is clear but not written in an active voice.	The message is clear and direct.
Grammar and Punctuation	Words are misspelled, and punctuation is sloppy.	A few careless mistakes and typos are missed.	Grammar and punctuation is correct.

Rubric for Classroom Presentation (for individual or team)

	Not so hot	Getting warmer	Hot!
Introduction	People may be unclear about my/our topic because the introduction is weak.	My/our introduction is to the point, but it doesn't flow into the rest of the presentation.	My/our introduction grabs the audience's attention and gives a good idea of what the talk is about.
Issue Addressed	My/our storm water problem is vague and unclear. I/we still don't understand the topic.	I/we show a good understanding of the storm water issue, but some information is incomplete.	I/we obviously researched the storm water problem and have a full understanding of the topic.
Relevance	I/we present the problem but don't explain why it should matter to anyone.	I/we make a connection between the problem and the real world.	It is obvious to others why the storm water problem matters.
Organization	My/our presentation lacks a natural flow.	My/our work has a beginning, middle, and an end.	My/our presentation has an interesting opening, an informative middle, and a convincing conclusion
Word Choices	I/we use some of the same words over and over. Some words may be too confusing for others.	The words I/we use are bland or sound as if trying too hard to impress. I/we have a few noticeable pauses.	The words that I/we use are natural, yet distinct. I/we use similes or metaphors to describe my/our work.
Voice/Tone	My/our presentation is too formal or informal. I/we use a monotone voice as if not interested in the topic.	My/our tone is okay, but the presentation doesn't sound personal. I/we need to include personal thoughts.	I/we sound excited about the research. I/we tell how I/we think and feel about it.
Visual Aid	My/our visuals are difficult to read. I'm/we're reading directly from the visual.	My/our visuals help explain the issue and solution, but include too many points. They need to be less flashy.	My/our visuals help make the issue and solution clear to the audience. I/we maintain eye contact with the listeners.
Conclusion	Listeners weren't sure when presentation was done. I/we didn't give a summary statement.	The ending of the presentation was clear. The general statement ties it all together.	The summary used is unique and pulls all the parts together. I/we leave the audience with a final thought.

Assessment:

- Identify an audience, and explain how you would develop effective information for that audience.
- Identify an audience, and explain how you would develop information for that audience that is completely off target.
- Explain why it is important to implement Best Management Practices (BMPs) at homes and businesses for a healthy watershed. (BMPs are methods and techniques designed to reduce or eliminate sources of water pollution).

Extensions:

Brainstorm other ways to help promote a healthy watershed such as storm drain stenciling, planting a demonstration rain garden or building rain barrels. Other ideas are listed in the Background Section of the *Storm Water Curriculum and Teaching Guide.*

Resources:

2003. *Getting in Step: A Guide for Conducting Watershed Outreach Campaigns.* United States Environmental Protection Agency. Washington, D.C. (EPA 841-B-03-002) www.epa.gov/nps/outreach.html

NPS Outreach Digital Toolbox. US Environmental Protection Agency. Washington, D.C. http://www.bae.ncsu.edu/programs/extension/wqg/nmp_conf/presentations/john.pdf

University of Wisconsin Extension, Environmental Resources Center. http://wateroutreach.uwex.edu/

Resources for Teachers - Extension Activities

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5. Super Sleuths, *Project Wet: Curriculum and Activity Guide*
6. Water Purifiers, *WOW! The Wonders of Wetlands*.

I. Understanding Water

1. **Activity: How Thirsty Is the Ground?**
Summary: This activity helps students to understand how percolation tests are performed, the properties of different soil types, how land usage relates to permeability and the oxygen content in various soil types. Using a coffee can and soil type demonstration, students learn how fast an area absorbs surface water, and in turn how long it takes to fill watersheds and aquifers. This is a great follow-up activity on a soil composition unit and a great introduction to water contamination.
Grade Levels: 3-12
Subjects: earth science, environmental science
Source(s): Higgins, Susan and Mark Schilling (Eds.). 2003. *WOW! The Wonders of Wetlands*. Bozeman, Montana: The Water Course. p.239-44.

2. **Activity: Water across the Curriculum**
Summary: These activities are interdisciplinary and encapsulate many key water issues relevant to today. These activities cross over from history, mathematics, social studies, art and science, which makes them more useful and educational. There are activities dealing with water conservation, waste water treatment, water contamination, aquifers, the water cycle, sedimentation, dilution, global distribution and much more. Some of them involve measuring parts per million, researching historical events, simulating soil layers, acting out the stages of the water cycle and providing opportunities for fun field trip ideas. These activities are a great way to incorporate global and domestic water related issues into just about any part of the lesson plan.
Grade Levels: 6-8
Subjects: cross-curriculum
Source(s): Grant, Tim and Gail Littlejohn (Eds.). 2004. *Teaching Green: The Middle Years.* Gabriola Island, BC: New Society Publishers. p.102-6.

3. Activity: The Water Game
Summary: This is an outdoor game played among trees. On the trees are cards with different water forms. The students must locate the water forms while trying to evade Toxins (selected children in bright colored vests) and answer the educator’s questions (playing the role as Conservative Officer) about water pollution, conservation and general facts. There are various ways to gain and earn points to achieve a different place in the hierarchy of the water cycle. This is a fun, interactive introduction to water conservation, population problems, water pollution and the importance of clean watersheds.
Grade Levels: 2-3
Subjects: science
Source(s): Grant, Time and Gail Littlejohn. 2005. *Teaching Green: The Elementary Years*. Gabriola Island, BC: New Society Publishers. p.136-40.

4. **Activity: Water Models**
Summary: This is an activity that teaches students about condensation and evaporation while they build a model of an ecosystem to see how the water cycle’s components and

processes will work. Then students use other models of ecosystems to see whether the water cycle happens the same way in every ecosystem. This is a great experiment that teaches students about the properties of water while educating them on water cycles in different climates all over the world.
Grade Levels: 5-6
Subjects: earth science, ecology, ecology, physical science
Source(s): 1998. *Project Wet: Curriculum and Activity Guide.* Bozeman, Montana: The Water Course. p.201-5.

II. Defining a Watershed

1. **Activity: Branching Out**
Summary: This activity helps students understand the interconnectedness of streams, lakes, rivers and watersheds. They build a temporary or permanent landscape model, and then predict where the rain would flow. Then students make it rain colored water with a water pail to see if their predictions are correct. This is a great model because each student can create a model, and it does not require a large amount of material or space.
Grade Levels: 6-8
Subjects: earth science, geography
Source(s): 1998. *Project Wet: Curriculum and Activity Guide.* Bozeman, Montana: The Water Course. p.129-32.

2. **Activity: Discovering Dips**
Summary: This activity is designed for the preparation of a planned wetlands area but can be adapted to understand how water flows over the land and the geography of the school grounds. Younger students can watch surveyors at a local construction site or have a surveyor come in and demonstrate how they use their equipment. They can also make clay models of the highs and lows of their schoolyard. Older students can learn how to use the equipment and make a topographic map of the area. Pairing younger students with the older group also creates an interactive educational forum. This is a great way to begin to understand where water flows over the land and where water comes to a rest.
Grade Levels: K-4, 5-12
Subjects: science, mathematics
Source(s): Ripple, Karen and Edgar Garbisch. 2000. *POW! The Planning of Wetlands.* St. Michaels, Maryland: Environmental Concern, Inc. p.178-89.

3. **Activity: Educating the Community: A Watershed Model Project**
Summary: This project gives many students, teachers, volunteers and community members the chance to get involved in the learning process. The idea is to plan a scale model of the area watershed with brick, mortar, cement and a little muscle. Then paint the model according to terrestrial and aquatic landmarks. After it is completed, students can present how the watershed works with a water hose creating rainfall, streams and lakes. This is a good opportunity for cooperative education about how to educate the community and to make a lasting learning tool.

Grade Levels: 3-5
Subjects: science, social studies
Source(s): Grant, Tim and Gail Littlejohn. 2005. *Teaching Green: The Elementary Years*. Gabriola Island, BC: New Society Publishers. p.164-68.

4. **Activity: Find Your Watershed**
Summary: This activity is a useful introduction to a watershed, water management or water quality unit. Students learn to use city and topographic maps. They use them to locate the water source on one map and then on the other map, as well as where the contour drainage dividing line is located. They use what they know about elevation, water flow, and different local landmarks to help them outline their local watershed. This activity teaches students about watersheds and how to use one of the most widely used scientific maps.
Grade Levels: 6-10
Subjects: physical science, ecology, geology
Source(s): *Boulder Area Sustainability Information Network*:
http://bcn.boulder.co.us/basin/learning/mappingteacher.html

5. **Activity: A Working Model of a Stream**
Summary: Using the Kingfisher Stream Model created by Neil Brooks, a classroom can create a model of a stream, where it flows, how local farms and factories affect it, how far pollution travels, how to stop erosion, and the uses of dams, retention ponds and other such structures. There is an indoor and outdoor version available, but both include a sandbox with some elevation, water hose, toy houses and farm animals. With a little imagination, there are endless possibilities given for materials that can be used to create different stream elements to demonstrate local watersheds, runoff, erosion and point-source pollution.
Grade Levels: 2-5
Subjects: science, ecology
Source(s): Grant, Tim and Gail Littlejohn. 2005. *Teaching Green: The Elementary Years*. Gabriola Island, BC: New Society Publishers. p.141-44.

III. Water Management and Conservation

1. **Activity: A Drop in the Bucket**
Summary: This less time-consuming activity helps students understand why and how water is a limited resource on Earth. Using a liter of water to represent all the fresh water available for human consumption and then using eye droppers to disperse it appropriately, the activity ends by showing students just how little is left to distribute among the world's human population. This is a great introduction to water management, water conservation and global issues surrounding this problem.
Grade Levels: 6-8
Subjects: earth science, mathematics, geography
Source(s): Higgins, Susan and Mark Schilling (Eds.). 2003. *WOW! The Wonders of Wetlands*. Bozeman, Montana: The Water Course. p.158-61.

2. **Activity: On the Edge**
Summary: This activity helps students learn the challenges of managing a resource that crosses political boundaries. It teaches them about the processes of negotiation, compromise, cooperation, and decision-making by creating two “countries” and having them find a way of sharing a limited resource (candy). Certain students will take on the rolls of interpreter and negotiator. This activity teaches students about working as a team, as well as international law and water management as a whole. It works well in conjunction with or in place of other water management activities, especially among older students as they increase their knowledge of global water management issues.
Grade Levels: 9-12
Subjects: geography, history, anthropology, environmental science, government
Source(s): 2002. *Discover a Watershed: The Watershed Manager Educator’s Guide.* Bozeman, Montana: Discover a Watershed Series. p.168-72.

3. **Activity: Our Watery Planet**
Summary: There are several activities here that demonstrate water conservation on a global scale. There is a water bucket relay to demonstrate how people with limited resources in the world collect their water supply, a way to calculate how much water individual students use, how much fresh water is available for human consumption, how unevenly water is distributed throughout the world, how difficult it is to find fresh water and what dehydration means for developing nations of the planet. These activities are educational and interactive while providing teachers with the opportunity to fit global issues into a limited amount of time.
Grade Levels: 6-8
Subjects: science, social studies, mathematics
Source(s): Grant, Tim and Gail Littlejohn (Eds.). 2004. *Teaching Green: The Middle Years.* Gabriola Island, BC: New Society Publishers. p.98-101.

4. **Activity: Pass the Jug**
Summary: This activity simulates different water rights policies, water availability and how people’s proximity to the resource influences how water is allocated. This activity can be done in a classroom with a jug of water and a few cups. Using various information about the students, set up an allocation system and ask how the students at the end of the line feel about being left out. This activity illustrates the social and governmental aspects of water allocation, and can be used in conjunction with or in place of other water management activities.
Grade Levels: 6-8
Subjects: social studies, environmental sciences, history, government
Source(s): 2002. *Discover a Watershed: The Watershed Manager Educator’s Guide.* Bozeman, Montana: Discover a Watershed Series. p.100-5.

5. **Activity: The Watershed Manager**
Summary: This activity gives students the opportunity to construct an abstract model using a mobile to demonstrate the balance among water users in a watershed. This helps students gain an introductory knowledge of the different types of water users and the issues surrounding water management.

Grade Levels: 4-8
Subjects: natural science, environment, civics, art
Source(s): 2002. *Discover a Watershed: The Watershed Manager Educator's Guide.* Bozeman, Montana: Discover a Watershed Series. p.120-23.

6. **Activity: 8-4-1, One for All**
Summary: This activity shows the interconnectedness of water users in a community watershed, demonstrates the complexity of sharing this resource, and teaches them how to negotiate moving past water management challenges along the river. Using teams of students, a large working space like a gymnasium, a water jug and obstacles, students have to maneuver themselves to the end of the river to find out how much water is left over in the end. This activity also illustrates importance of the adequate amount, cost, time and quality of water. This is great for understanding the importance of watersheds and how the government must regulate the watersheds.
Grade Levels: 4-8
Subjects: government, environmental science
Source(s): 2002. *Discover a Watershed: The Watershed Manager Educator's Guide.* Bozeman, Montana: Discover a Watershed Series. p.64-71.

IV. Water Quality and Pollution

A. The Facts and Problems of Runoff

1. **Activity: No Place to Run to**
Summary: This activity will help students understand the concept of imperviousness and runoff absorption. They will also be able to identify urban water pollutants. Students create a model of a city using sponges as porous grassland and Styrofoam as parking lots. After pouring pollution or dyed water onto the model they see where water is absorbed, where it will run off and how it collects in drains. Students have the opportunity to redesign their model to get the best results. This can help students begin to understand how everyday pollution infiltrates local watersheds.
Grade Levels: 5-9
Subjects: science, social studies, language arts
Source(s): *Air and Waste Management Association*

2. **Activity: Runoff Race**
Summary: This activity is a fun contest that shows students how wetlands and other variables help filter runoff and improve water quality. Using a variety of materials on an incline, students learn how different vegetation, and soil types help slow and filter water before it enters a watershed or another ecosystem. This is a good introduction to understanding water contamination, the effects of runoff and how students can improve water quality on a large scale.
Grade Levels: 2-12
Subjects: earth science, geology
Source(s): Higgins, Susan and Mark Schilling (Eds.). 2003. *WOW! The Wonders of Wetlands*. Bozeman, Montana: The Water Course. p.210-11.

3. **Activity: Snow and Tell**
Summary: There are several activities available here that demonstrate snowpack and its role in the watershed, factors in snowpack runoff, snow water equivalency, and the importance of studying snow. Students make models and work with real snow to simulate the process used by the SNOWTEL system to collect data about snow. This is a wonderful activity in conjunction with rainwater runoff activities, because it lends itself to watershed curriculum in the winter months.
Grade Levels: 6-8
Subjects: physical science, environmental science, geography, mathematics
Source(s): 2002. *Discover a Watershed: The Watershed Manager Educator's Guide.* Bozeman, Montana: Discover a Watershed Series. p.79-85.

4. **Activity: Will Stormwater Run Off?**
Summary: This activity is designed for the preparation of a planned wetlands area but can be adapted to understand where stormwater runoff goes on the school grounds. For the younger grades, students will follow drains, outlets and downspouts to see where water flows. This same exercise can be measured with food coloring added to water poured down drains. Older students can use topographic maps and the measured water flows taken by younger students to figure out where the water ends up and how much of it reaches this point. This is a great warm-up activity for understanding how stormwater reaches watersheds and includes assessments, as well as extensions.
Grade Levels: K-4, 5-12
Subjects: science, mathematics
Source(s): Ripple, Karen and Edgar Garbisch. 2000. *POW! The Planning of Wetlands.* St. Michaels, Maryland: Environmental Concern, Inc. p.163-68.

B. Other Important Issues

1. **Activity: Groundwater Cleanup Contest**
Summary: This is a simulation designed to teach students about pollution, how quickly it can infiltrate ground water, proper waste disposal, and complete contamination removal, while encouraging students to use their problem solving skills. The object is to neutralize the contamination before the pollution spreads throughout the entire aquifer (or colors the whole sponge). Students come up with an action plan to implement and then devise how to dispose of the contaminates. This quick thinking game incorporates many issues of water pollution and the challenges of keeping a watershed clean.
Grade Levels: 3-8
Subjects: science, ecology
Source(s): Lynn B. Entine and Karin E. Van Vlack. 1993. *Watersheds – Getting to Know Your Stream .* Dane County Water Watchers, Dane County Extension.

2. **Activity: Home Site Checklist**
Summary: Students can do this activity at home with or without a parent/guardian. Provided is a checklist to learn where the students' water comes from, in what ways it could get contaminated, how to check for contamination, how to tell if their water system is being maintained at a high level of efficiency, how to tell where they can reduce their

water usage, what to do with hazardous wastes if they are present, alternatives to salting driveways, reducing pet and yard waste, reducing runoff to streets and how to further conserve water on a daily basis. This activity can be used as a follow-up to a water management, water contamination or watershed usage unit, and it offers adults a chance to learn along with the students.
Grade Levels: 5- 12
Subjects: science, social studies, ecology
Source(s): Elaine Andrews. 1996. *Give Water a Hand Action Guide.* UWEX Environmental Resources Center, UW-Madison.

3. **Activity: Nutrients: Nutrition or Nuisance?**
Summary: This simulation illustrates the movement of chemicals, nutrients and energy through a water system such as a marsh or watershed. Using musical instruments, students learn how to interpret the benefits of some nutrients and dangers of other excess nutrients in a water system. They also learn the filtering ability of wetland plants. This activity addresses a problem that is often forgotten or misunderstood in terms of pollution and excess nutrients.
Grade Levels: K-8
Subjects: environmental science
Source(s): Higgins, Susan and Mark Schilling (Eds.). 2003. *WOW! The Wonders of Wetlands*. Bozeman, Montana: The Water Course. p.188-91.

4. **Activity: Sum of the Parts**
Summary: This activity illustrates how everyone contributes to water pollution and what everyone can do about it. Students piece together their “river front property” and then show how pollution passes down the chain of water to collect at the end. Students learn about point and non-point source pollution and responsibility for rivers and lakes, as well as how to identify Best Management Practices to reduce this pollution. This is a terrific warm-up for showing students why it is important that everyone takes responsibility for personal actions and works to maintain optimal water quality.
Grade Levels: 4-8
Subjects: environmental science, government
Source(s): 2002. *Discover a Watershed: The Watershed Manager Educator’s Guide* & 1998. *Project Wet: Curriculum and Activity Guide.* Bozeman, Montana: Discover a Watershed Series. P.114-18, 267-270..

5. **Activity: Super Sleuths**
Summary: This activity encourages students’ understanding of waterborne illnesses. They will have to identify the role of transmitting diseases and analyze the characteristics of environments that promote the transmission of these diseases around the world. They will do this by “acquiring” a waterborne illness and searching for other classmates that have similar symptoms. This is an interactive opportunity to educate students on the plight of developing nations and why water quality is important.
Grade Levels: 6-9
Subjects: health, life science, geography

Source(s): 1998. *Project Wet: Curriculum and Activity Guide.* Bozeman, Montana: The Water Course. p.107-15.

6. **Activity: Water Purifiers**
Summary: This activity helps students understand mechanical, chemical and natural water filtering processes. They learn the process of how their drinking water is treated for consumption, how to identify waste products of water treatment, which water treatment process is most efficient, and what human and natural resources are used in the treatment process. Students get hands-on experience with how to filter their polluted jar of water mechanically, chemically and naturally. This is a great way to connect students to the importance of their own local water quality, as well as introduce or follow-up a water contamination unit.
Grade Levels: 6-12
Subjects: environmental science, chemistry
Source(s): Higgins, Susan and Mark Schilling (Eds.). 2003. *WOW! The Wonders of Wetlands*. Bozeman, Montana: The Water Course. p.215-19.

More Information and Resources

1. Adopt-A-Watershed- Curriculum Materials Catalog and Leadership Courses at www.adopt-a-watershed.org

2. Project Wet (Water Education for Teachers) - Provides educators with teaching materials for ages 5-18 in water awareness, appreciation, knowledge and stewardship. www.projectwet.org

3. WAV (Water Action Volunteers) - WAV is a statewide program for citizens who want to learn about and improve the quality of Wisconsin's streams and rivers. WAV offers informational materials, training and support for citizen stream monitoring, storm drain stenciling, river cleanups and other projects. http://clean-water.uwex.edu/wav/

4. Wisconsin's DNR (Department of Natural Resources) - Dedicated to the preservation, protection, management and maintenance of Wisconsin's natural resources by implementing laws, educating citizens, coordinating disciplines and providing outdoor recreation. http://www.dnr.state.wi.us

5. Water Watchers (Dane County Extension) - Water Watchers offers training on water and watershed topics, provides curriculum resources and guides, and lends equipment. Water Watcher volunteers monitor stream water quality, restore stream banks, and help curb urban and rural runoff pollution. http://clean-water.uwex.edu/wav/werclocations.htm

6. Wellhead Protection Project - Assists homeowners and farmers to voluntarily protect groundwater. http://www.dnr.state.wi.us/org/water/dwg/gw/whp/WHP-sum.html

Resources for Students

Locating Your Watershed
Web Sites -

Surf Your Watershed www.epa.gov/surf

About WDNR's Hydrologic Areas
http://www.dnr.state.wi.us/org/gmu/sidebar/whatis.htm#gmus

Online Watershed Interactive Learning
Web Sites -

Bell Museum of Natural History, Watershed Planning Game
http://www.bellmuseum.org/ecogames.html

Storm Water Information - General
Fact Sheets -

Wellhead Protection Project *Better Homes & Groundwater: A Homeowner's Guide.* http://www.dnr.state.wi.us/org/water/dwg/gw/pubs/bhgw.pdf

WDNR *Answers to Your Questions on Well Abandonment*:
http://dnr.wi.gov/org/water/dwg/gw/pubs/abandonment.pdf

University of Wisconsin Extension/Wisconsin DNR Publications.
…*Cleaning Up Storm Water Runoff* (UWEX Publication GWQ016)
…*Polluted Urban Runoff*. (UWEX Publication GWQ020)
…*Storm Drain Stenciling.* (UWEX Publication GWQ015)
…*Storm Sewers: Rivers beneath our Feet.* (UWEX Publication GWQ004)
Available in Spanish or English at *Dane* County's Extension Office: (608) 266-4106 or through Rock River Basin Educator, UW-Extension, Jefferson County, 864 Collins Road, Jefferson, WI 53549-1976; Phone: 920-674-8972; order on the Web at http://cecommerce.uwex.edu or http://dnr.wi.gov/education/

Web Sites -

Chern, Laura, Maureen Mecozzi, Dave Johnson. 2006. Wisconsin Natural Resource Magazine*: Groundwater, Protecting Wisconsin's buried treasure*. Wisconsin Department of Natural Resources. Madison, WI.
http://www.wnrmag.com/supps/1999/aug99/intro.htm

EPA Adopt Your Watershed: http://www.epa.gov/adopt/

EPA Polluted Runoff (Non-point Source Pollution) for Kids:
http://www.epa.gov/OWOW/NPS/kids/

Madison Area Municipal Storm Water Partnership: www.myfairlakes.com

Wisconsin Department of Watershed Management:
http://www.dnr.state.wi.us/org/water/wm/

Increasing Infiltration

Downspout Disconnection
Fact Sheets -

Schueler, T., Swann, C., Wright, T., Sprinkle, S. 2004. Downspout Disconnection Manual 8: *Pollution Source Control Practices.* Center for Watershed Protection. Ellicott City, MD

…2004 *Fact Sheet: Downspout Disconnection.* Paxton Creek Watershed and Education Association. Harrisburg, PA. http://www.paxtoncreek.org/

…*How to Disconnect Downspouts.* Clean Rivers. Portland, OR. http://www.portlandonline.com/shared/cfm/image.cfm?id=25270

Building Rain Gardens
Fact Sheets -

… Brochure Series: *You are the Solution to Water Pollution: Keep rainwater in its place?* Dane County Lakes and Watershed Commission. Madison, WI.

… *Build Your Own Rain Garden*. Chesapeake Bay Foundation. http://www.cbf.org/site/DocServer/rain_garden_guide-web.pdf?docID=2869

…*How to Install a Rain Garden* (Instructional Flyer). South River Federation and Center for Watershed Protection. http://www.cwp.org/Community_Watersheds/brochure.pdf

… *How to Build a Rain Garden.* Dane County Lakes and Watershed Commission. Madison, WI. www.co.dane.wi.us/commissions/lakes/

University of Wisconsin Extension/Wisconsin DNR Publications.
…*Rain Gardens: A how-to manual for homeowners. (*DNR Publication PUB-WT-776 2003, UWEX Publication GW0037)
…*Rain Gardens: A household way to improve water quality in your community* (UWEX Publication GWQ034).
Available at *Dane* County's Extension Office: (608) 266-4106 or through Rock River Basin Educator, UW-Extension, Jefferson County, 864 Collins Road, Jefferson, WI 53549-1976; Phone: 920-674-8972; order on the Web at http://cecommerce.uwex.edu or http://dnr.wi.gov/education/ Download at http://myfairlakes.com/what_more.asp#yardgarden_raingardens

Web Sites -

…*How to Build a Rain Garden.* Rain Gardens of West Michigan. www.raingardens.org

…Native Plant List for Wisconsin Rain Gardens (Interactive HTML)
http://www.dnr.state.wi.us/org/water/wm/nps/rg/plants/PlantListing.htm
Dane County Lakes and Watershed Commission: Rain Garden Information.
http://www.co.dane.wi.us/commissions/lakes/raingarden.shtml

… A Web based homeowner guide for building and maintaining a rain garden. Rain Garden Network: http://www.raingardennetwork.com/index.htm

Rain Barrels
Fact Sheets -

… 2002. *Fact Sheet #7 Rain Barrels.* Center for Watershed Protection. Ellicott City, MD

… 2000. *Build a Simple Rain Barrel.* Maryland Green Building Program, Maryland Department of Natural Resources.
http://www.dnr.state.md.us/ed/rainbarrel.html

… 2002. *How to Build and Install a Rain Barrel.* (Instructional Flyer) South River Federation and Center for Watershed Protection.
http://www.cwp.org/Community_Watersheds/brochure.pdf

Web Sites -

...*Rain Barrels: Capital idea in capturing and reusing roof runoff.* Alliance for the Chesapeake Bay. Baltimore MD. http://www.acb-online.org/

…*Harvest Water with Rain Barrels* http://rainbarrelguide.com

Reducing Impervious Surfaces

Native Landscaping
Books-

Currah, R. & Van Dyk, M. 1983. *Prairie Wildflowers- An illustrated manual of species suitable for cultivation and grassland restoration*. Friends of the Devonian Botanic Gardens. University of Alberta, Edmonton.

Curtis, John T. 1959. *The Vegetation of Wisconsin.* The University of Wisconsin Press. Madison, WI

Dindorf, Carolyn, Carrol Henderson, and Fred Rozumalski. *Lakescaping for Wildlife and Water Quality*. Minnesota DNR. Saint Paul, MN.

Kirt, Russell R. 1995. *Prairie Plants of the Midwest: Identification and Ecology*. Stipes Publishing Company. Champaign, IL.

Ladd, Doug. 1995. *Tallgrass Prairie Wildflowers: A Field Guide.* Falcon Publishing Inc. Helena, Montana

Messer, Gretchen. 2001. *Wisconsin Native Plant Sources.* University of Wisconsin-Extension. Madison, Wisconsin. http://clean-water.uwex.edu/pubs/native/index.htm

Mirk, Walter. 1997*. An Introduction to the Tall Grass Prairie of the Upper Midwest.* The Prairie Enthusiasts. Boscobel, WI.

Smith, Roberts J. and Beatrice S. Smith. 1980. *The Prairie Garden: 70 Native Plants You Can Grow in Town or Country.* The University of Wisconsin Press. Madison, WI.

Fact Sheets -

University of Wisconsin Extension/Wisconsin DNR Publications.
…*Shoreline Plants and Landscaping.* (UWEX Publication GWQ014),
…S*torm Water Basins: Using natural landscaping for water quality & esthetics* (UWEX Publication GWQ045).
Available at *Dane* County's Extension Office: (608) 266-4106 or through Rock River Basin Educator, UW-Extension, Jefferson County, 864 Collins Road, Jefferson, WI 53549-1976 Phone: 920-674-8972; order on the web at http://cecommerce.uwex.edu or http://dnr.wi.gov/education/

Web Sites -

Prairie Enthusiasts' Web Site: http://www.theprairieenthusiasts.org/

Wild Ones Natural Landscapers Ltd. *Landscaping with Native Plants* http://www.for-wild.org/landscape

Porous Pavement
Fact Sheets -

Porous Pavement Fact Sheet. Storm Water Manager's Resource Center http://www.stormwatercenter.net/

Storm Water BMP Design Supplement for Cold Climates. Center for Watershed Protection. Ellicott City, MD

Storm Water Technology Fact Sheet: Porous Pavement. United States Environmental Protection Agency, Municipal Technology Branch. Office of Water, Washington, D. C. EPA 832-F-99-023.

Pavers and Turf Pavers:
Fact Sheets -

Fact Sheet #8 Impervious Surface Reduction. Center for Watershed Protection. Ellicott City, MD.

Green Roofs
Books -

McDonough, W., Braungar, M. 2002. *Cradle to Cradle: Remaking the Way We Make Things*. North Point Press. New York, NY.

Web Sites -

Ford Motor Rouge River Plant
http://www.ford.com/en/goodWorks/environment/cleanerManufacturing/rougeRenovation.htm

Green Roofs for Healthy Cities: http://www.greenroofs.net/

Green Roofs: Storm Water Management From the Top Down by Katrin Scholz-Barth
http://www.edcmag.com/CDA/Archives/d568f635d8697010VgnVCM100000f932a8c0

Green Roofs & L.I.D.– Green Roofs
http://www.dcgreenworks.org/LID/greenroofs.html

Urban Ecology Center, Milwaukee, WI: http://urbanecologycenter.org/

Improving Water Quality

Yard Care:
Books-

Eagan D.J. (Editor). 1997. *Home*A*Syst An Environmental Risk-Assessment Guide for the Home.* University of Wisconsin System. Madison, WI.

Henderson, C. L., Dindorf, C., Rozumalski, F. *Landscaping for Wildlife and Water Quality.* Minnesota DNR. St. Paul MN.

Schueler, T., Swann, C., Wright, T., Sprinkle, S. 2004. *Manual 8: Pollution Source Control Practices.* Center for Watershed Protection. Ellicott City, MD

…1993. *Bay Book: A Guide to Reducing Water Pollution at Home*. Alliance for Chesapeake Bay. Baltimore, MD.

Fact Sheets -

Fact Sheet #1 Lawn Care Practices/Reducing over Fertilization. Center for Watershed Protection. Ellicott City, MD

Fact Sheet #2 Integrated Pest Management. Center for Watershed Protection. Ellicott City, MD

…*Fact Sheet #4 Pet Waste Management.* Center for Watershed Protection. Ellicott City, MD

…Brochure Series: *You are the Solution to Water Pollution: Chop down all your trees?, Astroturf your lawn?, Never Change Your Oil?* Dane County Lakes and Watershed Commission. Madison, WI.
http://www.danewaters.com/press/waterpollution.aspx

University of Wisconsin Extension/Wisconsin DNR Publications
…*Brown Water, Green Weeds* (UWEX Publication GWQ003)
…*Beneficial Landscape Practices* (UWEX Publication GWQ008)
…*Lawn and Garden Pesticides* (UWEX Publication GWQ011)
…*Lawn and Garden Fertilizers* (UWEX Publication GWQ002)
…*Lawn Watering* (UWEX Publication GWQ012)
…*Lawn Weed Control* (UWEX Publication GWQ013)
…*Managing Leaves and Yard Trimmings* (UWEX Publication GWQ022)
…*Pet Waste and Water Quality* (UWEX Publication GWQ006)
…*Practical Tips for Home and Yard* (UWEX Publication GWQ007)
…*Rethinking Yard Care* (UWEX Publication GWQ009)
Available in Spanish or English at *Dane* County's Extension Office: (608) 266-4106 or through Rock River Basin Educator, UW-Extension, Jefferson County, 864 Collins Road, Jefferson, WI 53549-1976; Phone: 920-674-8972; order on the Web at http://cecommerce.uwex.edu or http://dnr.wi.gov/education/

Web Sites -

City of Madison Web Site: http://webapp.cityofmadison.com/streets/index.html

Madison Area Municipal Storm Water Partnership: www.myfairlakes.com

…*Properly Disposing Pet Waste.* Clean Water Campaign. Atlanta GA.
http://www.cleanwatercampaign.com/what_can_i_do/pet_waste_home.html

…*Top Five Ways to Help Dane County Lakes and Stream*s. Dane County Lakes and Watershed Commission. Madison. *WI*
http://www.danewaters.com/private/tips.aspx

Conserving Water

Web Sites –

…2002. *H2ouse Water Saver.* California Urban Water Conservation Council. Sacramento, CA. www.h2ouse.org

…*Water-Efficient Landscaping, Using Water Wisely in the Home, Using Water Efficiently: Ideas for Residences, Ideas for Industry, Ideas for Communities, Ideas for Commercial Businesses.* Water Efficiency Program. Environmental Protection agency, Washington, DC. http://www.epa.gov/owm/water-efficiency

Storm Water Vocabulary

- Algae: They are simple single-celled, multi-celled or colonial, aquatic plants that contain the green pigment chlorophyll. They grow by absorbing nutrients (nitrogen and phosphorus) from the water or sediments. They add oxygen to the water during the process of photosynthesis and represent the basic component of the aquatic food chain.
- Algae Blooms: Refers to the harmful and excessive growths of algae generally caused by excessive nutrients in the water. This often results in scum forming on the water surface and it is associated with a foul odor. These blooms can be potentially harmful to fish, wildlife and humans in extreme situations.
- Allocate: The share or portion given.
- Aquifer: Underground porous rock or sediment that holds groundwater.
- Base flow: The low water level in a perennial stream; that portion of a stream flow derived from groundwater.
- Best Management Practices: Methods determined by land and water managers to describe land use measures designed to reduce or eliminate nonpoint source pollution.
- Bioaccumulation: The progressive build-up of a substance or pollutant that collects in the animal's tissue resulting from repeated exposures. Animals farther up the food chain have higher concentrations, because each level acquires the build-up of the previous level. An example would be that the big fish eating the little fish would equal all the build-up that the little fish acquired from the many, slightly polluted algae it ate.
- Condensation: The process by which a gas turns into a liquid.
- Conservation: The protection, preservation, management, or restoration of wildlife and of natural resources such as forests, soil, and water.
- Dissolved Oxygen (DO): The dissolved oxygen content is an indication of the status of the water with respect to the balance between oxygen-consuming and oxygen-producing processes. Fish and other desirable clean water biota require relatively high dissolved oxygen levels at all times.

- Ecosystem: All of the interacting systems and organisms in association with their interrelated physical and chemical environment.
- Eutrophication: The process by which lakes and streams are enriched by nutrients (nitrogen and phosphorus), which leads to excessive plant growth or algae blooms.
- Evaporation: A physical change where a liquid turns into a vapor or gas.
- Evapotranspiration: A process in which water dissipates into the atmosphere by evaporation from moist soil and plant transpiration.
- Fecal Coliform Bacteria: These are found in the intestinal tracts of warm-blooded animals. Just like *E. coli*, they are used as microbiological indicators that determine the safety of the water for drinking or swimming. They originate from many sources that include bird droppings, pet waste, livestock waste, failing septic systems, stormwater runoff, and sanitary and combined sewer overflows.
- Food Chain: This is the transfer of food energy from successive levels of organisms. An example of this would be algae being eaten by invertebrates, which in turn are eaten by small fish, which are the eaten by larger fish, which are eventually eaten by people.
- Function: The purpose or benefit provided by a specific stage/aspect of a process.
- Groundwater: Water that infiltrates into the ground and renews/recharges underground aquifers.
- Habitat: The given physical characteristics define a particular habitat, whether it is trees for shading fish or deep pools that fish can escape to during a drought. The combination of these different aspects set different habitats apart from each other.
- Headwaters: The source of a stream or river.
- Hydrologic cycle: A circulation of water from a water body to the atmosphere, to the land, back to open water either above or below ground, or directly back into the atmosphere. This is also known as the water cycle.

- Impervious: Not capable of being penetrated or non-permeable. An example would be roads and parking lots that prevent runoff from being absorbed into the soil.
- Impoundment: To accumulate and store in a reservoir.
- Infrastructure: The basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and waterways.
- Infiltration: The movement of water through the soil.
- Landscape: This is defined by the various characteristics, whether natural or man-made, that create the geological features that distinguish one part of the earth's surface from another part. An example would be hills, fields, forest, and water.
- Land use: This describes the dominant types of human activities which are prevalent in the dominant geographic area where they occur. An example would be cropland, forest, pasture land, suburban and urban developments.
- Mainstem: The principal watercourse or stream formed by the smaller contributing tributaries that flow into it.
- Natural Resource: A material source of wealth, such as timber, fresh water, or a mineral deposit, that occurs in a natural state and has economic value.
- Nitrogen: This is one of several nutrients needed by all plants and animals. This is the key component of proteins, and as plants/animals live and die they release many nitrogen compounds into their surrounding environment.
- Nonpoint Source Pollution: This comes from diffuse, undefined sources; it is usually associated with land uses like urban development and agriculture. This kind of pollution and the stormwater runoff it occurs in is considered the most threatening to the nation's water quality.
- Pathogens: An agent that causes disease, especially a living microorganism such as a bacteria or fungus.
- Pervious: Able to be penetrated or permeable. This is a surface that allows rainwater to be absorbed into the soil. An example would be lawn or grasslands.
- Phosphorus: This is one of the major nutrients required for plant nutrition. Excess concentrations can lead to rapid algae or plant growth causing the condition of

accelerated aging of waters or eutrophication. It can enter waterways through many sources which include domestic/industrial wastewater discharge, agriculture, and fertilization of urban and suburban areas.

- Point Source Pollution: Water pollution from an identifiable point or source of pollution such as a pipe or drainage ditch, and the pollutant and its source is known.
- Pollution: The destruction or contamination of a natural resource usually by harmful substances entering the environment.
- Precipitation: Any form of water, such as rain, snow, sleet, or hail that falls to the earth's surface.
- Riparian: The banks or edges of a natural course of water.
- Runoff: Rainwater that flows over the land because the ground and vegetation cannot absorb it.
- Sediment: Solid fragments of material (inorganic or organic) that come from the weathering of rock and are carried by wind, water, or ice, especially those which settle to the bottom of water.
- Sedimentation: The process of depositing or forming sediment.
- Storm sewers: They collect stormwater runoff from streets and yards then deliver that water to a river, lake or local watershed every time it rains or the snow melts.
- Stormwater runoff: The overflow of surface water due to a heavy rain or snowstorm.
- Temperature: This is important to aquatic organisms, because it affects the ability of oxygen to dissolve and the toxicity of various substances found in the water. This also influences the rate of biochemical processes, metabolism, respiration and reproduction of aquatic organisms.
- Topography: the arrangement of the surface of the landscape including hills, valleys, and the positions of natural and man-made features.
- Transpiration: A process where water moves up a plant and out of its leaves as water vapor, and into the atmosphere.
- Tributary: A stream that contributes its water to another stream or body of water.

- Turbidity: This is suspended particles found in water and it is measured by a particle's ability to scatter sunlight. Excessive turbidity can clog the gills of fish and mussels, and can cover the bottom habitats of invertebrates and fish spawning areas.
- Watershed: The entire land area draining into a specific body of water. Watersheds are divided by ridges of high land. This can also be called a Drainage Basin or Water Basin.
- Water users: Anyone who uses water. The various categories of users include domestic, public, industrial, commercial, agriculture, energy production, mining, recreation, fish and wildlife, and navigation.

Storm Water Curriculum & Teaching Guide Feedback Form

Thank you for piloting this storm water unit with your students. We appreciate your feedback to help us develop high quality educational materials for Wisconsin educators interested in teaching about storm water impacts and action-oriented solutions. Your comments will remain confidential. Please answer the following questions:

1. What went well as you implemented the storm water unit with your students?

2. What would you change and/or recommend as modifications?

3. Were the activity directions clear and simple to follow? If not, what would you recommend to make them more user-friendly?

4. Did the activities fit the suggested time frames? If not, what could be eliminated or shortened?

(see over)

5. From your observations, how did the students react to the content? Were they interested in finding solutions to local storm water issues?

6. What suggestions do you have to enhance this storm water unit?

7. Would you use this unit again with your students? Why or why not?

8. Please check which activities you did with your students.

___ PowerPoint Presentation

____ Background Reading

___ Water in the Watershed

____ Follow the Drop

___ "Water" You Doing with Hydrology? (A Water Inventory)

___ Outreach Materials: Solutions to Storm Water Pollution

___ Resources for Teachers

___ Resources for Students

___ Vocabulary

9. Would you be willing to share the summary results of the "Water Inventory" and examples of students' outreach materials? If so, please include them with the feedback form.

Thank you for your time filling out this form! Your feedback is important and valuable for developing a curriculum worthwhile for teachers and meaningful for students.

Please send your feedback using the enclosed envelop.
If desired, email your feedback to cherylbauer@wisc.edu

If you have any questions or additional comments, please feel free to call Cheryl at 608/262-5264 or write to Cheryl Bauer-Armstrong, UW-Madison Arboretum,1207 Seminole Highway, Madison, WI 53711