Stormwater & NPS Pollution Curriculum Materials

For the Spring Creek Watershed

Prepared by:

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Prepared for:

Lodi High School

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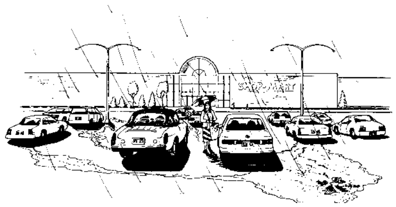
Stormwater & Nonpoint Source Pollution Curriculum Materials for
Lodi Spring Creek and Spring Creek Watershed



Stormwater and Nonpoint Source Pollution - Part I

Program Purpose
To provide students with an understanding of what nonpoint source pollution is, where it is happening in their community, and how to assess nonpoint source pollution impacts using web-based computer tools.

Length of Program
50 minutes for lesson
50 minutes computer lab time
2 weeks for homework assignment

Ages
Grades 10th-12th

Maximum Number of Participants
None

Objectives
After completion of all activities, students will be able to:

- Define watershed, pervious/ impervious surface, erosion, nonpoint source (NPS) pollution and give examples of NPS pollutants
- Explain how and why NPS pollution negatively affects water quality
- Explain the difference between pervious and impervious surfaces.
- Name some examples of erosion control best management practices.
- Collect visual data (evidence) of NPS pollution and erosion control best management practices within their community
- Use the DNR Webview internet site to determine existing land use types in the City of Lodi and Spring Creek Watershed

Preparation
Before the class arrives:

1. Set up computer with internet access and projector screen (LCD) or television monitor
2. Save websites to "favorites" and load NPS PowerPoint on desktop
3. Have 1 disposable camera for every pair of students
4. Make copies of computer lab and homework assignment sheets (1 per student)

Basic Outline
I. Greeting/Grabber: Nonpoint source pollution impacts
II. Computer Tools: DNR Webview *(20 minutes)*
III. Homework Assignment: Expectations & Safety *(10 minutes)*

Materials
- 1 computer with internet access per 2 students
- 1 disposable camera per 2 students
- Copies of Computer Lab Instruction sheet and Computer Tools Worksheet (1 per student)
- Background information for teacher
- Powerpoint slides of erosion and BMP's

Greeting/Grabber
Start with asking the students some general questions:

1) How many students in the room fish?
2) Where do you fish and what do you catch?

Start Power Point Show

Ask what a healthy fishing habitat looks like. It probably looks something like **slide 2**. *(Start the Powerpoint presentation with the river slide).*

Now tell the students you are going to show them some slides **(slides 3, 4 and 5)** of pollution and ask them what they see. The students will probably identify "erosion" taking place. Ask them to define erosion if they can.

<u>Erosion</u> - Physical wearing of the earth's surface by wind or water. Wind and water carry soil or sediment from where it originated to a different place.

In **slide 6**, students see soil being washed down a storm drain. Ask the students where the water goes when it enters a storm sewer. The students may think that storm sewers drain to municipal treatment plants, but they don't! Storm drains and ditches empty directly into our local waterways (*stormwater runoff is not treated!*) (**slide 7, 8 and 9).** How big of a problem is this? (*It's a **big** problem.)* In order to understand why, we have to understand what stormwater runoff is, and that means understanding watersheds. Ask the students the following questions:

3) What's a watershed **(slide 10)**? (*An area of land that drains into a particular body of water).*
4) How is a watershed determined? (*The boundary of a watershed is defined by the highest point of land. A drop of water that lands on top of a hill will follow the path of least resistance to the lowest spot. Hilltops separate one watershed from another).*

Show the Spring Creek watershed **(slide 11)**, and explain that watersheds also have sub-watersheds. Ask the students:

5) If you toss a McDonald's Quarter Pounder wrapper out your car window in Lodi, where does it go **(slide 12-17)**? (*the Lodi Spring Creek subwatershed of the Lake Wisconsin watershed. The Lake Wisconsin Watershed is a subwatershed of the Wisconsin River Watershed. The Wisconsin River Watershed is a subwatershed of the Mississipi River Basin watershed. The spring creek subwatershed is 46.6 square miles, and makes up about 1% of the Lower Wisconsin River watershed*).
6) What's your watershed address? (*Spring Creek subwatershed, Lake Wisconsin, Wisconsin River, Mississippi River.)*
7) What are the other major watersheds in Wisconsin? *(Lake Michigan Basin, Lake Superior Basin)*

When rain falls in a watershed, it can do one of three things: infiltrate (soak into the ground), evaporate, or run off.

Water that falls on pervious surfaces (lawns, gardens, forests, meadows) can infiltrate into the soil. Water that falls on impervious surfaces (pavement, rooftops, concrete) cannot soak in; only evaporate or runoff. **Water that does not soak into the ground or evaporate is called *stormwater runoff*.** Urban areas (towns, cities, villages) have tremendous problems with runoff because there's a higher percentage of impervious surfaces, which means more water enters storm sewers more quickly **(slides 18 and 19)**.

Storm water is not clean water. Ask the students how many of them would be willing to wash their dishes in the street during a rain storm (eew!) Why not? Because stormwater contains a variety of pollutants, called **nonpoint source pollution (slide 20)**.

<u>Nonpoint Source Pollution (NPS):</u> Pollutants carried by stormwater that originate from a variety of land use activities. Ask the students to list some examples of nonpoint source pollution:

- ✓ Lawn fertilizer
- ✓ Oil
- ✓ Antifreeze
- ✓ Soil or sediment
- ✓ Pet waste
- ✓ Livestock manure
- ✓ Leaves
- ✓ Grass clippings
- ✓ Heavy metals (zinc, copper, cadmium, mercury, from brake linings of vehicles and air pollution)

Now ask the students if they can answer these questions:

8) What % of WI's rivers are listed by the DNR as "threatened" or "degraded" because of NPS pollution? *(40%)*
9) What's the #1 pollutant in WI's lakes and rivers by volume? (*Soil or sediment)*
10) What are the primary nonpoint source pollutants to the Lodi subwatershed? (*Sediment, fecal material, and heavy metals).*

Soil or sediment is the #1 pollutant to WI's waterways. Excess sediment fills shallow lakes and creeks, increasing water temperature. Sediment deposited on the eggs of fish, amphibians, and macroinvertebrates clogs the porous membrane and prevents oxygen from reaching the embryo. Soil also carries with it other pollutants that adsorb to its surface chemically, like phosphorous.

11) Phosphorous is a common ingredient in commercial fertilizers. But in water, excess phosphorous encourages algae and plant growth **(slide 21)**, which requires oxygen. Unlike terrestrial environments where oxygen is an abundant resource, it is a limiting factor in aquatic environments. Rapid algal and plant growth depletes oxygen in

the water, lowering dissolved oxygen levels and reducing the number of high quality fish species (like brook trout) that can survive **(slide 22)**. Additionally, the decay of materials such as leaves and grass in water also lower dissolved oxygen levels because the bacteria utilize oxygen. The result is a fishery dominated by species that can tolerate low oxygen levels (like carp). Consider some facts about Spring Creek? Do you think non-point source pollution impacts Spring Creek in Lodi **(slides 23-27)?**

There are two broad categories of storm water management practices: short term practices that occur **during construction**, and long term practices that are **post-construction**. Show the students PowerPoint slides of both types of erosion control practices and explain that as they photograph the watershed, these are some of the stormwater management practices they should be looking for.

During Construction

Silt fence: (Leaky dam) A sheet of porous material dug partially into the ground and staked. It is designed to let water through, but trap silt **(slide 28-29)**.
Matting: (Looks like burlap). It is designed to hold soil in place on slopes.
Straw: Also designed to hold soil in place on slopes, but more short term solution until vegetation grows **(slide 30)**.
Tracking pads: Basically a large stone driveway. They keep vehicles from tracking mud onto and off of the site **(slide 31)**.

Post-Construction

Grass swale: A ditch with vegetation where water is directed to. Designed to catch some sediment while water travels through **(slide 32)**.
Detention basin: (Wet pond) Designed to hold water long enough for sediment to settle to the bottom **(slide 33)**.
Bioretention basin: (Dry pond) Designed to hold water in place long enough for it to infiltrate into the soil. They are usually vegetated with diverse types of deep-rooted plants, and underlain by an engineered soil mixture. Both of these measures help to filter pollutants out of runoff so that it doesn't contaminate groundwater, and to improve infiltration of water into the ground **(slide 34)**.

Stream buffers: Land immediately adjacent to a stream is kept natural **(slide 35-36)**.
Wetland preservation: Not building on wetlands; they act as natural water filters**(slide 37)**.

In this lesson, the students will be asked to photographically document evidence of both erosion from urban development or other areas, and stormwater management practices that they observe. Students will learn how to use an internet based tool to help them map where both erosion and stormwater management practices are happening within Lodi.

Computer Tools

The students will be trained to use the Wisconsin DNR Webview program to observe land-use patterns and natural resources on a community- and watershed-wide scale. What they observe and measure will then be used to calculate changes in stormwater quantity and quality based on changes in land use since pre-settlement times, in Part II of this lesson.

Twenty minutes will be devoted to introducing the Wisconsin DNR Webview program during the class period. Students will then have one week to complete the Computer Worksheet assignment and photographic documentation assignment. What the students complete now will form the basis for part II of this lesson.

Wisconsin DNR Webview program

(http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=webview)
The Wisconsin DNR Webview program provides online access to Wisconsin DNR Geographic Information Systems (GIS) data. The website allows you to create and print customized maps for your area.

Pass out one Computer Lab Instruction Sheet and one Computer Tools Worksheet to each student. Have the students follow along as you access the Wisconsin DNR Webview website, and look up a map of Lodi High School. Demonstrate how to find a location in Webview and calculate area. Refer often to the Instruction sheet. Encourage the students to take notes on the sheet if it is helpful.

Homework Assignment

Ask students to complete the Computer Tools Worksheet for two sites. Go through each column, using Lodi High School as the example. Then go over ground rules for taking the photolog assignment BEFORE passing out the cameras.

1. DO NOT enter private property without permission! Stay on public areas (i.e., sidewalks, parking lots, etc.)
2. LOOK before you take a picture. Be aware of where you are in relation to traffic. Keep yourselves safe.
3. Take 2-3 photos per site. If you think one may not turn out (finger over the flash, etc.), take another. You have 27 exposures and are only assigned 20 pictures. We expect ONE goofy shot (on purpose).
4. Turn in used cameras to the teacher for development.

Answer any questions the students have.

Glossary of Terms

Adsorb – to attract and hold to a surface (minute particles)

Erosion - Physical wearing of the earth's surface by wind or water. Wind and water carry soil or sediment from where it originated to a different place.

Impervious surface-Substrate that does not allow water to penetrate through

Nonpoint source pollution- Pollutants carried by stormwater that originate from a variety of land use activities

Pervious surface-Substrate that water can penetrate and move through

Pre-settlement vegetation -The vegetation that occurred across Wisconsin's landscapes at the time of European settlement.

Stormwater management practices-A variety of techniques designed to trap and hold sediment or stormwater before it enters waterways (streams and rivers)

Stormwater runoff-Water that does not soak into the ground or evaporate

Watershed- An area of land that drains into a particular body of water

REFERENCES

WDNR, *Lower Wisconsin State of the Basin Report*, July 2002.

COMPUTER TOOLS
INSTRUCTION WORKSHEET – PART I

1. Open your internet browser (Internet Explorer, Mozilla Firefox, etc.) and type in the web address for the **Wisconsin DNR Surface Water Data Viewer program:** http://dnrmaps.wisconsin.gov/imf/imf.jsp?site=SurfaceWaterViewer

2. The surface water data viewer homepage will pop up. To find a location, go to the third button from the left that says **Find Location**. Click on **City or Village,** type in “Lodi” and click **Go!**

3. To zoom in on Lodi, click on the **Zoom In** button above the map. Your cursor will become a cross. Click the area on the map you want to zoom in on. A bar will appear with a moving red line that says “Loading Map.” Wait for the map to refresh.

4. If you don’t see an aerial photo of Lodi at this point, then you’ll have to change the base layer to a Digital Air photo. (If you see an aerial photo, then move on to the next step.) Click on the first tab on the left hand side that says **Layers**. Scroll down and click on the  next to **Imagery & Basemaps**. Click in the box that says NAIP **2005 Color Air Photos**. An aerial photo will load. You can zoom in on photos as described above.

5. If, the City of Lodi is shaded light yellow on the screen and obscures the aerial photo, click the first tab on the left hand side that says **Layers**. Then click on the  next to **Admin & Political Boundaries** and uncheck the box next to **Cities and Villages**.

6. To move the view of the map, click on the button above the map that says **Move**. You can then click on the map, hold, and drag the map to recenter. A new, re-centered map will refresh. In **Advanced Tools**, the move icon looks like this: . Click and drag to re-center the same way.

7. To see what the pre-settlement vegetation community was in any area of the City, click on the next to **Forests and Landcover**, then check the box next to **Original Vegetation Cover**. To see what each color means on the original vegetation map, click on **Legend** button, second from left, near the top of the screen.

8. You can draw polygons to define the limits of your two sites. Click on the polygon markup icon that looks like this: , then click on the map and draw a polygon to define the limits of your site. Click the OK button when you are done, and then click OK again. The map will refresh with your site boundary polygon point shown.

9. To calculate the area of your two sites, you need to switch to the advanced tool set. Click on the right-hand most button above the map that says **Advanced Tools** and has the red suitcase icon. Click on the measure icon that looks like this: . Click on a point on the map that you want as your starting point. A set of latitude and longitude coordinates will appear on to the left of the map. Then click on a second point on the map. A red line will appear between the two points, with the distance in feet calculated for you. To get a triangle shaped area, click on a third point on the map. A triangle will be drawn, second line will appear, and a second distance in feet will appear, as well as the total distance of all lines. To get a polygon shape, click on a fourth and/or fifth point. The surface water viewer will calculate the area of your polygon.

10. To print off a map of your site, click on the Printer icon that looks like this: . To the left of your map, the **Create a Map** title will appear. Type your site name into the **Map Notes** box. Click on the grey **OK** button to create an Adobe Acrobat file of your map. You can then print or save your map.

HOMEWORK ASSIGNMENT

Part 1. Computer

1. Get into partner teams and name your team. Write your team name on your `Stormwater Computer Tools Worksheet - I.`
2. Look at the aerial photo on the Surface Water Data Viewer, and find your two sites. Chose your areas so that within each of the two areas, the land use type is the same (e.g. the entire area of each site is residential or commercial or industrial, or farmland, etc.). However, the two areas should be different land use types.
3. Then, use the **Original Vegetation Cover** layer to determine what the pre-settlement vegetation community was for each of your two sites. If there was more than one vegetation type, then estimate or measure amount of each type.
4. Use the to draw the boundary of you're your first site.
5. Use the  to measure the area of your first site.
6. Print a .pdf of the aerial photo of the first site, with the polygon drawn with the  tool illustrating the extent of each site. To do this, click on  and then click the "OK button at the bottom left of the screen. Once your map has been created, right click on the "open map" link, then click "Save Target As" and save your map in a folder.
7. Repeat steps 4 through 6 again for your second site, and fill out your worksheet.

Part 2. Photolog Activity

In order to help the group to better understand the stormwater issues in the City of Lodi, your assignment is to go out and take up to TWENTY photos of things you observe in your community that relate to any of the stormwater or nonpoint source pollution issues we discussed in class today. Keep a log the location of each photo on the attached form, and return the photo and the used camera to your teacher. You have ONE week to take the photos and turn in the disposable cameras to your teacher for development. Bring your completed `Stormwater Computer Tools Worksheet – I` and your three printed maps to the next class.

It is important to take pictures of both positive and negative things related to stormwater and water quality that you observe in Lodi and the surrounding area. On the log sheet:

Circle the "+" if the topic of your photo is "positive/asset";
Circle the "–" if the topic of your photo is a "negative/liability"

What should I take pictures of? Examples include:

- Problem areas or other areas impacted by storm water management (e.g. flooding, clogged inlets, erosion, algae blooms, etc. - these are great to catch after a good rainfall!)
- Examples of effective storm water infrastructure or management techniques in the City (e.g., street sweeping, stormwater detention areas, storm drains, etc.)
- Examples of impervious areas in town
- Examples of natural or man-made filtration areas
- Examples of "stuff" that gets into our storm water system (e.g., litter, sediment, chemicals, etc.)
- Anything else of note that is related to stormwater, Spring Creek, water quality and/or non-point source pollution.

STORMWATER COMPUTER TOOLS WORKSHEET – I

Partner Team Name: ___________________________

Site ID	Location Description	Area	Current Land Use	Pre-Settlement Land Use
Example	Lodi High School, 1100 Sauk St	31.9 acres	Commercial/ Institutional	Forest
Site 1				
Site 2				

Urban Land Use Category Descriptions

Low Density Residential - Single family housing, with a density of 2 or fewer units per acre. Includes house, driveway, yards, sidewalks, and streets.

High Density Residential - Single family or mulit-famiy housing, with a density greater than 2 units per acre. This includes houses, driveways, yards, sidewalks, and streets.

Commercial - Areas where the primary function of buildings involves the sale of goods or services. For the purposes of this exercise, this category also includes institutional lands such as post offices, courthouses, fire and police stations, churches, hospitals and schools. This land use includes the buildings, parking lots, and streets.

Industrial - Businesses such as lumber yards, auto salvage yards, junk yards, grain elevators, agricultural coops, oil tank farms, coal and salt storage areas, slaughter houses, and areas for bulk storage of fertilizers. This category also includes buildings used for the storage and/or distribution of goods waiting further processing or sale to retailers, such as warehouses, and wholesalers.

Forest – areas covered by a dense growth of trees, plants, and underbrush.

Grass/Pasture – Prairie, grassland, or grazing areas

Agricultural – Land used for the production of crops

Water and Wetlands- Open water, such as a lake or stream, or lowland areas, such as a marsh or swamp, that are saturated with moisture near the ground surface during some or all of the year.

Spring Creek Watershed Stormwater & Nonpoint Source Pollution Lesson

PHOTO LOG EXERCISE

Photos Taken by: ____

Camera No. __________

Photo #		Subject of Photo	Location of Photo (street address, if known)
1.	+ / –	____________________	______________________________
2.	+ / –	____________________	______________________________
3.	+ / –	____________________	______________________________
4.	+ / –	____________________	______________________________
5.	+ / –	____________________	______________________________
6.	+ / –	____________________	______________________________
7.	+ / –	____________________	______________________________
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14.	+ / –	____________________	______________________________
15.	+ / –	____________________	______________________________
16.	+ / –	____________________	______________________________
17.	+ / –	____________________	______________________________
18.	+ / –	____________________	______________________________
19.	+ / –	____________________	______________________________
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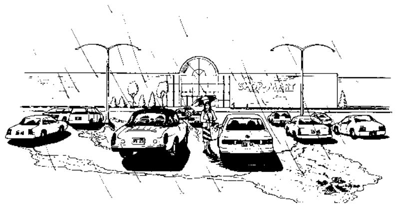


Stormwater and Nonpoint Source Pollution - II

Program Purpose
To use information gathered in Part I and a new web-based computer tool to calculate information on stormwater runoff quantity and quality by land use category, and to identify individual and community actions to improve runoff water quality in their community.

Length of Program
50 minutes for lesson
50 minutes computer lab time

Ages
Grades 10th-12th

Maximum Number of Participants
None

Objectives
After completion of all activities, students will be able to:
• Locate photographic evidence of erosion and stormwater management practices on a City of Lodi map.
• Use the Long-Term Hydrologic Impact Assessment (L-THIA) internet site to estimate changes in runoff and nonpoint source pollution.
• Discuss and name three simple things they can do as students to improve water quality and watershed health at home, work, or school.

Preparation
Before the class arrives:
• Set up computer with internet access and projector screen (LCD) or television monitor
• Save websites to "favorites"
• Hang the sticky wall on the chalkboard or other open wall area
• Make copies of computer lab and homework assignment sheets (1 per student)

Basic Outline
I. Greeting/Grabber: Sharing of erosion and SW BMP photos and map locating *(20 minutes)*
II. Computer Tools: L-THIA model to estimate water quality *(15 minutes)*
III. Simple things to do at home to improve water quality *(10 minutes)*
IV. Careers in water quality *(if time permits)*

Materials
- 1 computer with internet access per 2 students
- 38x48 map of Lodi
- Packet of small-size sticker dots
- String and scissors
- Developed photos from students
- Sticky wall (if not available, then large wall area where students can hang up their photos, see glossary for sticky wall definition)
- Scratch paper for BMP categories
- Copies of L-THIA Instruction sheet and Computer Tools-Part II Worksheet (1 per student)
- Background information for teacher
  - "Home Hot Spots for Water Quality" poster
  - "Storm Sewers: The Rivers Beneath our Feet" & "Special Focus: Urban Actions for Cleaner Water" Handouts

Greeting/Grabber: Sharing, Mapping and Grouping photos

Have the students move their desks or tables to make room for the 38x48 map of Lodi. The students have two tasks to complete in the next 15 minutes:

1) Each person must choose 4 photos that they consider to be their most significant, two "positive" and two "negative." They will place a dot on the Lodi map that represents the location of the photo, and connect a string from that dot to the photograph that represents that site. Green dots represent "positive" locations and red dots represent "negative" locations.
2) Each person must place their remaining photos somewhere on the sticky wall. The goal is to group like photos together. Spend a few minutes brainstorming categories with which to group photos. Write each category on a piece of scratch paper and place on the sticky wall. There is no right or wrong way to group photos, as long as it makes sense given the type and range of photos taken. Allow students to add additional categories if necessary after they begin grouping. (Examples of some possible categories include erosion control practices, post-construction stormwater management practices, nonpoint source pollution, impervious area, natural resources. Each of these categories could be further subdivided into positive/negative examples of each.)

   Reiterate the 15 minute time frame in which to do this. Supervise the students as they do both activities.

   After time is up, gather the students around the map and try to make some general conclusions. *Are there areas of town with more positive or negative dots? What does this indicate? Is there an area that has lots of erosion currently happening? What is their general impression of the amount of erosion versus the number of BMPs?* Leave open to many answers.

Second, ask the students to examine the groupings of photos on the sticky wall. *Overall, did the students observe BMPs that appeared to working effectively or that appeared to be ineffective? How many construction site BMPs did the students photograph compared with post-construction BMPs? How much erosion did the students observe while photographing? What is the students' general impression of the stormwater best management practices currently utilized in Lodi? Is it adequate?* Emphasize that these are opinion questions, and there are no right or wrong answers.

Computer Tools

Ask the students to take out their Computer Tools worksheets. Open the L-THIA program on the screen and pass out the L-THIA Instruction sheet and Computer Tools– part II Worksheet. The students have two sites they will be using to calculate volume of runoff and water quality data. They will be using their printed maps and L-THIA to calculate how much runoff increased as a result of current development, relative to pre-settlement conditions.

L-THIA

The Long-Term Hydrologic Impact Assessment (L-THIA) model is an accessible online tool to assess the water quality impacts of land use change. Based on community-specific climate data, L-THIA estimates changes in recharge, runoff, and nonpoint source pollution resulting from past or proposed development, and is most appropriate for areas of 20 or more acres. It estimates long-term average annual runoff for land use and soil combinations, based on actual long-term climate data for that area.

Go through the instruction sheet with the students and demonstrate how to input data into the program to calculate runoff quantity and quality. Demonstrate how to make bar graphs and print them off. This students' homework assignment will be to do this either during a later class period or on their own, depending on teacher preference.

**Note to teacher: You can debrief this activity with the following questions: *Which land use practice resulted in the biggest increase in stormwater runoff? Did a particular land use create a large increase in any one particular nonpoint source pollutant? In general, what can students conclude about the relationship between land use and stormwater runoff quantity and quality?* Leave open to many answers.

Simple Things You Can Do To Improve Water Quality

So far the students have been looking at stormwater runoff and water quality from a community perspective. Next, ask the students to brainstorm what an individual can do to improve stormwater quality. Ask them to think back to the major sources of nonpoint source pollutants. *What pollutants are generated at home, and how can an individual minimize those pollutants?* After a few minutes of brainstorming, bring out the "Home Hot Spots for Water Quality" poster. Simple things the students can do include:

1) Wash the car on the lawn or gravel driveway (increase infiltration and trap pollutants)
2) Use phosphate free detergents
3) Clean up oil spills when changing the oil in your car; recycle used oil
4) Use grass clippings and leaves as mulch for gardens and landscaping, or bag.

Bring up the Clean Waterways website: http://www.cleanways.org/ and examine the list of actions an individual can take to improve water quality.

There are many ways to improve water quality on a community level. Erosion control at construction sites is just one example. Incorporating post-construction stormwater management practices into new developments is another.

Street sweeping is another common practice to remove organic matter before it enters waterways. For example, from the City of Lodi sweeps its down streets on the weekly basis, and the rest of the City monthly.

Careers in Water Quality

If time permits, give a brief summary of various careers in water quality. There are many careers that involve improving water quality in many diverse organizations, including:

- DNR – Stormwater, drinking water, wetlands
- Environmental consulting firms
- Educational institutions (Universities, colleges, high schools, middle schools, elementary, and Extension services)
- Non-profit organizations (River Alliance, Sierra Club, Local Watershed Organizations, etc.)
- City and Village Community Development Departments
- Water Resources and Civil Engineering Firms
- County Land and Water Conservation Departments

This list is not exhaustive. Give the students time to ask questions about the careers.

Glossary of Terms

Hydrologic Soil Group (HSG) Soils are classified by the Natural Resource Conservation Service into four groups based on the soil's runoff potential. The four groups are A, B, C and D; A's have the smallest runoff potential and D's the greatest.

- **Group A** is sand, loamy sand or sandy loam types of soils. They have low runoff potential and high infiltration rates.
- **Group B** is silt loam or loam soils. They have a moderate runoff potential and moderate infiltration rates.
- **Group C** soils are sandy clay loam soils. They have low infiltration rates and high runoff potential.
- **Group D** soils are clay loam, silty clay loam, sandy clay, silty clay or clay. This HSG has the highest runoff potential and very low infiltration rates.

Land Use- A category that describes how a parcel of land is being utilized. Generally City, Village, County, or Regional Community Planning Departments define the categories.

Sticky Wall – A large piece of lightweight nylon fabric, approximately 145cm x 300cm. Sticky walls are can be hung and covered with spray adhesive, for the convenient display and repositioning of cards or photos during workshops. They are foldable and can be reused over and over again.

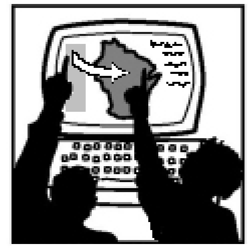
REFERENCES

Clean Waterways website: http://www.cleanways.org/

Long Term Hydrologic Impact Assessment website: www.ecn.purdue.edu/runoff/lthianew/.

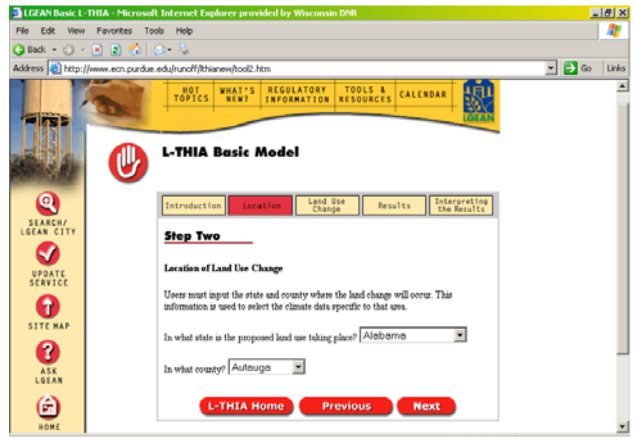
Storm Sewers: The Rivers Beneath Our Feet (1993). UWEX Publication #: GWQ004

Long-Term Hydrologic Impact Assessment



Purpose: To understand how changes in land use over time has changed the amount of runoff and non point source pollution in the Spring Creek Watershed.

Part 1: Changes Runoff and Non-Point Source Pollution on Individual Sites



1. Using your Internet browser, go to www.ecn.purdue.edu/runoff/lthianew/.

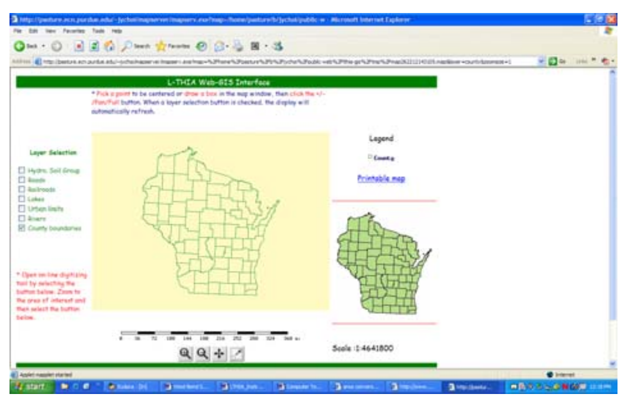
2. Click on the button for **Basic L-THIA.**

3. Read the "Introduction to Basin L-THIA", then Click **Next** to advance to Step Two.

4. Enter your location by clicking on the dropdown menus and highlighting your state and county. Click **Next** to continue.

5. Using the drop down menu, select the type of current land use at your site (e.g., forests, agriculture, low-density residential, etc.).

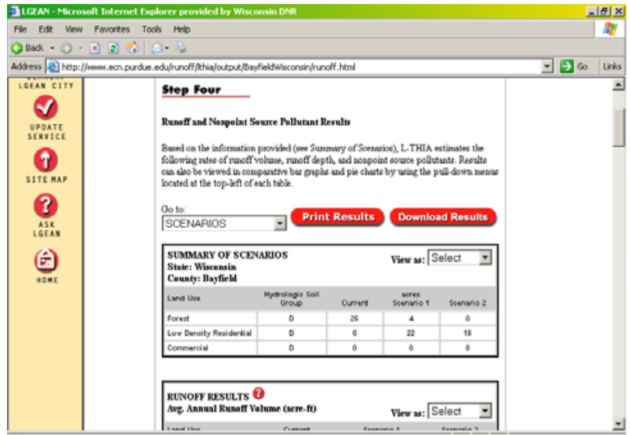
6. Next enter the soil type in the drop down box. To determine the hydrologic soil group for the soil type at your location, refer to the Lodi Hydrologic Soil Group map provided by your teacher. *Hydrologic Soil Group* (HSG) refers to of a group of soils with a similar potential of to generate runoff. For example, sandy soils have low runoff potential and belong to HSG A, whereas clayey soils have high runoff potential and belong to HSG D.

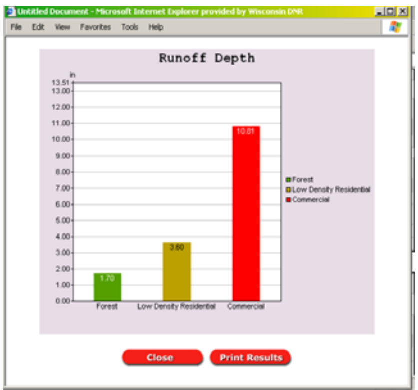


7. Next you will need to specify what units the area will be entered as. Click on the drop down menu above the box chart and select **acres**. Since you calculated area in square feet, you will need to convert square feet to acres. You can do this by hand, or go to the Science Made Simple website to calculate the conversion for you: http://www.sciencemadesimple.com/conversions.html

8. Enter the area in acres in the box under "**Current**." Then, in the second row, enter the pre-settlement use and the same soil type listed in the first row. Then enter in "**0**" under the "**Current**" box, and enter in the site area in the "**Scenario 1**" box. (For example, if you had 2.1 acres under industrial land use in the first row, and the pre-settlement land use is forest, then in the second row you'd enter "**Forest**" as the land use. Then, in the "**Forest"** Row, you'd put a "0" in the box under "**Current**." and 2.1 acres in the **Forest** row under "**Scenario 1**". The TOTAL number of acres must be the SAME for both scenarios or the calculation will not run. Click the **Next** button to continue.

9. Up will pop a series of boxes that will give you the runoff volume in several units by land use. Enter these numbers on your computer worksheet. It will also show you the amounts of a variety of nonpoint source pollutants. Enter in the amount of nonpoint source pollutants specified on your computer worksheet, and choose one more nonpoint source pollutant to enter on your worksheet and create a bar graph of.





10. To create bar graphs comparing the amounts of nonpoint source pollutants from the two land uses, click on the drop down menu that says "**`View As`**: **Select**" to the right of your pollutant of interest. Choose "**`Bar graph`**." A new window will pop up showing the bar graph. Print it out for each of your four chosen nonpoint source pollutants.

Part 2: Changes Runoff and Non-Point Source Pollution Watersheds-Wide

We learned earlier that the quality of Spring Creek is threatened due to a variety of sources. Use the L-THIA program procedures described above, and the data in the table below, to determine how the volume of runoff and amount of pollutants discharged from the Spring Creek Watershed into Spring Creek has changed over time.

After you're done, look at your data, and consider the following: *How do you think these changes in land use, runoff and pollutants have impacted the creek? Did you see anything in your photographs that reflect these changes?*

Spring Creek Watershed Land Use Summary*

Land Use	Area (Acres)	
	Pre-Settlement	Current
Forest	14,514	2,567
Grass/Pasture	14,505	657
Water/Wetlands	835	746
Agriculture	0	21,853
Commercial/Institutional	0	746
Industrial	0	30
High-Density Residential	0	1,194
Low-Density Residential	0	2,061

**Estimated, based on the Wisconsin Pre-Settlement Vegetation Map, City of Lodi land use mapping, and Dane and Columbia County land use mapping*

STORMWATER COMPUTER TOOLS WORKSHEET
Long Term Hydrologic Assessment Model

Location: ______________________**Total Area (acres):** ______________

Current: __________acres of ______________________land use

Pre-Settlement: __________acres of ______________________land use

Average Runoff: (in)

Current: ______________________________

Pre-Settlement: ______________________________

Phosphorous (lbs)

Current: ______________________________

Pre-Settlement: ______________________________

NPS Pollutant of Your Choice – *(Print off in bar graph form)*

Type: _______________________________

Current: _______________________________

Pre-Settlement: _______________________________

Location: ______________________**Total Area (acres):** ______________

Current: __________acres of ______________________land use

Pre-Settlement: __________acres of ______________________land use

Average Runoff: (in)

Current: ______________________________

Pre-Settlement: ______________________________

Phosphorous (lbs)

Current: ______________________________

Pre-Settlement: ______________________________

NPS Pollutant of Your Choice – *(Print off in bar graph form)*

Type: _______________________________

Current: _______________________________

Pre-Settlement: _______________________________

STORMWATER COMPUTER TOOLS WORKSHEET –
Long Term Hydrologic Assessment Model

Partner Team Names: ___________________________

Part 2. Spring Creek watershed-wide runoff & nonpoint source pollution summary

	Pre-Settlement		Current	
	Amount	**Units**	**Amount**	**Units**
Runoff (Volume)				
Runoff (Depth)				
Nitrogen				
Phosphorus				
Suspended Solids				
Lead				
Biologic Oxygen Demand (BOD)				
Oil and Grease				
Fecal Coliform				

LAKE WISCONSIN WATERSHED (LW19)

The Lake Wisconsin Watershed is located mostly in Sauk and Columbia Counties although the southernmost tip extends into Dane County. The watershed is named for Lake Wisconsin, an impoundment of the Wisconsin River created by the Wisconsin Power & Light dam at Prairie du Sac. Overall population in the Lake Wisconsin Watershed for 2000 was estimated to be around 14,300. Main municipalities include the villages of Dane, Merrimac and Poynette and the City of Lodi. Population growth in the watershed is high, most likely as a result of the watershed's proximity to the City of Madison.

Table 1: Growth in Municipalities in the Watershed

Municipality	*1990*	*2000*	*% Change*
Dane	621	799	28.7%
Lodi	2,093	2,882	37.7%
Merrimac	392	416	6.1%
Poynette	1,662	2,266	36.3%

As with virtually all the other watersheds in the basin, agriculture predominates. Other land cover in the watershed consists of broad-leaf deciduous forest, and grassland. Lake Wisconsin is also a major feature and covers 6.5% of the watershed's area.

Table 2: Land Cover in the Watershed

Land Cover	*Percent of Watershed*
Agriculture	45.9%
Forest (Total)	26.6%
Broad-Leaf Deciduous	*23.5%*
Coniferous	*1.6%*
Mixed Deciduous/ Coniferous	*1.5%*
Grassland	14.3%
Open Water	6.6%
Wetland (Total)	4.8%
Forested	*1.8%*
Emergent/Wet Meadow	*1.6%*
Lowland Shrub	*1.4%*
Other	1.1%
Development	0.7%

Watershed At A Glance

Drainage Area (m^2): 199.5

Total Stream Miles: 95.5

Trout Stream Miles: 39.6

Sport Fishery Miles: 8.9

Lakes: Lake Wisconsin

Exceptional/Outstanding Resource Waters: Parfrey's Glen, Prentice (Durward) Rowan, Spring (Lodi)

Municipalities: Poynette, Lodi, Merrimac

Major Public Lands:
- Dekorra Public Hunting Grounds
- Hinkson and Rowan Creek State Fishery Areas
- Lodi State Wildlife Marsh
- Parfrey's Glen State Natural Area

Concerns and Issues:
- Development pressure
- Nonpoint source pollution
- Stream channelization
- Lack of shoreline fishing
- Atrazine
- Nutrient loading

Initiatives and Projects:
- Friends of Rowan Creek
- River Planning Grant for education and planning on Rowan Creek
- River Planning Grant to assess the Rowan Creek Watershed
- The Riverland Conservancy - land management and habitat restoration
- Wetland restoration
- Wild trout restoration
- Cold water habitat work
- Badger Army Ammunition Plant restoration
- Harmony Grove Lake Protection and Restoration District sediment study
- River Planning Grant on Spring Creek
- Aquatic habitat restoration in Gruber's Grove Bay

The watershed is developing at a high rate. This development pressure may impact natural plant communities and habitat and cause water quality problems if not controlled. There is also significant development around the lake that has a potential impact to Lake Wisconsin and its shoreline. As with all watersheds in the basin, the watershed does experience problems as a result of nonpoint sources of pollution and has been ranked as a medium priority with respect to nonpoint source pollution reduction. Portions of this watershed east of Poynette and along the county border are atrazine prohibition areas. See Appendix B. Point source discharges in the watershed have the potential to negatively impact surface water resources. The potential for groundwater contamination as a result of the former activities at the old plant is also an issue. Currently, drinking water concerns have been addressed and the Army is taking aggressive steps to ensure safe water. For more information, see the "Groundwater Contamination" section on page 42.

There are numerous permitted point source discharges in the watershed. Industrial discharges include Chiquita Inc., Lodi Canning and the U.S.Army Badger Ammunition Plant. Lodi Canning operates a vegetable canning operation in Lodi in Columbia County. It discharges noncontact cooling water to Spring Creek. Process wastewater is discharged to groundwater via spray irrigation. A break in the pipe carrying process wastewater to the spray irrigation field resulted in thousands of gallons of wastewater discharged to Spring Creek in 1991. This process wastewater pipe was completely replaced during 2000. U.S. Army Badger Ammunition Plant presently discharges wastewater to groundwater, but at one time it discharged to Lake Wisconsin at Grubers Grove Bay. The surface water discharge to Grubers Bay resulted in the contamination of lake bottom sediments. The US Army initiated a project to remove these contaminated sediments from Gruber's Grove Bay during 2001. The Army has installed a groundwater pumping and treatment facility to collect and treat contaminated groundwater on BAAP grounds. Approximately 4-5 million gallons per day are collected and treated prior to being discharge to Lake Wisconsin. Chiquita Inc. discharges to Hinkson Creek.

There are also several municipal discharges. Three of them, including Devil's Head Lodge, Harmony Grove and the Merrimac WWTP discharge to groundwater. The Lodi WWTP discharges to Spring Creek, and Poynette discharges to Rowan Creek.

There are two USGS stream flow gauging stations in the watershed on tributaries to Lake Wisconsin. The stations measure the stream's flow, the stage and the rainfall and are located near Prairie du Sac. For more information see the USGS website at http:\\wi.water.usgs.gov.

The Lake Wisconsin Watershed has a variety of good quality habitats and rare plant communities that are listed on the state's Natural Heritage Inventory, (NHI), kept by the Bureau of Endangered Resources. The south slopes of the Baraboo (South) Range, a Precambrian inlier set of hills, is partially within the watershed. These hills are heavily wooded and contain unique sub-ecosystems with rare plant species. Some of these communities and others throughout the watershed include:

- Bedrock glade
- Cedar glade
- Dry cliff
- Dry prairie
- Dry-mesic prairie
- Moist cliff
- Northern dry forest
- Northern dry-mesic forest
- Oak opening
- Sand barrens
- Southern dry forest
- Southern dry-mesic forest
- Southern mesic forest
- Emergent aquatic
- Floodplain forest
- Northern sedge meadow
- Northern wet forest
- Open bog
- Shrub-carr
- Southern sedge meadow
- Springs and spring runs, hard
- Stream, fast, soft and warm
- Stream, fast, hard, and cold

In addition to these special communities, the watershed is also home for a variety of rare plant and animal species including; 7 species of beetle, 14 species of birds, 3 species of butterflies, 7 species of dragonflies, 11 species of fish, 2 species of mayflies, 2 species of moths, 9 species of mussels, 33 plant species, 4 species of snakes, 1 species of mammal, 2 species of leafhoppers, 1 species of caddisfly, and 1 species of lizard. These plants and animals are also listed on the state's Natural Heritage Inventory (NHI).

There are several publicly owned recreation areas in the watershed. The Dekorra Public Hunting Grounds has 242 acres of land open for hunting and other activities such as birdwatching and berry picking. The Hinkson Creek Fishery Area is 160 acres that offers opportunities for trout fishing. The Rowan Creek Fishery Area is larger, covering 629 acres and offers opportunities for birdwatching, hiking, cross-country skiing, and trout fishing. The Lodi Marsh State Wildlife Area also lies within the watershed's boundaries. The marsh is home to pheasants, ducks and other wildlife. Visitors to the marsh can enjoy hiking, berry picking, and birdwatching. A portion of Devil's Lake State Park can also be found in the watershed. The 488 acre Parfrey's Glen State Natural Area is also located in the watershed.

Note: The Dane County portion of this watershed is also discussed in the Dane County Regional Planning Commission (DCRPC) Dane County Water Quality Plan*. The DCRPC plan should also be consulted for additional information, priorities and recommendations.*

STREAMS IN THE LAKE WISCONSIN WATERSHED

Hinkson Creek

Hinkson Creek is a small, low gradient, coldwater, Class II, tributary to Rowan Creek. Despite impoundments and a heated discharge from a canning factory in the headwaters, the stream is capable of supporting brook trout. Natural reproduction occurs in the upper stream while the lower half depends on stocking. Surrounding wetlands buffer the stream from adjacent land uses. Some cattle are present in the stream corridor on the lower end. Dense tag alder growth along some sections and beaver dams are the biggest management problems. Surveys conducted in 1998 found the fish community to be of good condition. Habitat quality was determined to be from fair to good.

Manley Creek

Manley Creek is a small tributary to the Wisconsin River. The stream supports some natural reproduction of brook trout and is considered a Class I trout stream. The stream has experienced some problems as a result of beaver activity on the creek.

A lot of habitat work has been done on the stream to help support this population of trout. Much of this work was completed on the portion of the stream that runs through property owned by Alliant Energy's Riverland Conservancy and has proven to be successful. This work was a cooperative project between the state, the Riverland Conservancy, and the Wisconsin Conservation Corp. Other projects currently underway on the Conservancy property in addition to streambank restoration includes wetland and prairie restoration.

Parfrey's Glen Creek

Parfrey's Glen Creek is a very small stream. The stream flows through a deep rocky canyon and the stream and glen possess scenic and scientific values. The stream supports a Class I population of brook trout in the upper 1.1 miles and is considered and outstanding resource water (ORW). The area around the creek has been designated as a State Natural Area. A rare aquatic species has been found in the creek in past surveys. Parfrey's Glen was last monitored in 1993.

Prentice Creek (Durward's Glen)

This stream is a tributary to the Wisconsin River. The stream supports a Class I trout stream above Highway 78. Below, the stream is designated as a Class III stream, although with some work a small portion of that stream could support a Class II trout stream. The upper 5 miles of the creek have been designated an exceptional water resource (ERW). The stream experiences some problems as a result of nonpoint sources of pollution.

Rowan Creek

Rowan Creek is classified as a trout stream for 12 miles of its length with some natural reproduction of brown trout. About four miles are Class I trout waters and designated as an exceptional water resource (ERW), while eight are Class II. Approximately 8 miles of the trout stream portion of the stream has been listed on the state's list of impaired waters. Despite this, the stream has been known as one of the best trout streams in Columbia County. Surveys conducted in 1998 found the stream to have fair to good fish community health and good to excellent habitat quality. There are nonpoint source pollution problems in its upper end due to cattle access, bank erosion, and cropland erosion. In addition, new housing developments are springing up, which has resulted in problems with stormwater runoff. A River Planning Grant, sponsored by Columbia County, has been granted to help examine current and potential stormwater issues along Rowan Creek. The grant will help with future stormwater planning and management to control this potential source of pollution.

As a result of the threat from nonpoint sources and the streams potential to support a healthy and fishable population of trout, the stream has been ranked as a high priority for nonpoint source pollution and would benefit as a nonpoint source pollution reduction project.

The Friends of Rowan Creek have also received a River Planning Grant. The grant will be used to facilitate educational and outreach activities in the watershed. The grant will also help the group to address problems and issues that affect the overall health of the watershed.

Spring Creek (Lodi Creek)
Spring Creek flows into Lake Wisconsin in Columbia County. It is Class II trout stream and the four miles of Class II in Dane County are considered an exceptional resource water (ERW). The stream flows through the Lodi Marsh State Wildlife Area above Lodi and is well buffered from agricultural impacts. Downstream of Lodi, the stream has experienced a decline in the natural reproduction of trout, which has been a cause of concern. Although significant spawning does occur in the riffles within the city limits, the stream has been straightened and lacks suitable hiding cover for fingerling fish. The WDNR has made efforts to address this problem and have completed a total of about one mile of stream habitat improvement work on different sections. In addition, a 15" minimum size limit has increased the number of 12" to 14" and 15" fish on the lower section of the stream. Additional habitat improvement along the stream on village park lands would help to improve this problem. Soil loss in the town of Lodi has been estimated at 6.1 tons per acre per year. This addition of soil to the stream, combined with sedimentation due to bank erosion and inputs from nearby barnyards can potential cause more problems in the stream. One further threat to the creek is the result of the tremendous growth in the Town and City of Lodi. Housing and industrial development has increased in the past 5 years. This development contributes a large volume of stormwater to the stream and is a major source of nonpoint source pollution. Spring Creek receives point source discharge from both a municipal and industrial source. The City of Lodi has recently renovated their treatment plant.

The Friends of Scenic Lodi Valley are interested in protecting the stream and have proposed a citizen stream monitoring program. Monitoring was conducted in 1999 and 2000 to collect some baseline data for this project. Fisheries surveys found several cold water indicator species in the creek and a few pollution intolerant species, but overall, there were more pollution tolerant species (white suckers and creek chubs) than other species. Similarly, macroinvertebrates collected were indicative of good quality water, yet below the city, the macroinvertebrates collected were indicative of stream disturbance, which could potentially be attributed to urban stormwater runoff from the City of Lodi.

To assist them with their efforts to protect and improve Spring Creek, the Friends of the Scenic Lodi Valley have received a River Planning Grant. The grant will help them to organize a stream monitoring network. The monitors will gather valuable information that will help to evaluate the overall health of the stream. The Friends plan on using the grant to conduct a watershed assessment to identify potential pollution sources and inventory land use near the stream. The grant is a cooperative project between the City of Lodi, the WDNR, Trout Unlimited, Lodi Canning and the Friends of the Scenic Lodi Valley.

Wisconsin River
The portion of the Wisconsin River that includes Lake Wisconsin flows through this watershed. For more information on the Wisconsin River, see page 90.

LAKES IN THE LAKE WISCONSIN WATERSHED

Lake Wisconsin

Lake Wisconsin is a large impoundment of the Wisconsin River created by the hydroelectric dam at Prairie du Sac. It has a good sport fishery and is used extensively for recreation. Because it is an impoundment, sedimentation and nutrient loading to the lake, and toxic substance accumulation in bottom sediments, are concerns. The nutrient loading impacts the lake by fostering algae blooms and affecting dissolved oxygen levels. Low levels of mercury, and high levels of PCBs have been detected in sturgeon from the lake. A fish consumption advisory for PCBs has been issued for the lake's sturgeon. Contaminated sediment sites exist in Grubers Grove Bay, an arm of the lake near the Badger Army Ammunition Plant (BAAP). Grubers Grove Bay received process waste water from the BAAP wastewater treatment facility in the past. Sediment samples were found to have extremely high mercury concentrations as well as high levels of lead and ammonia. In response to this, a major dredging project was conducted to remove the contaminated sediment. There are plans to restore the aquatic habitat in the Bay through the planting of rooted aquatic plants and shoreline trees as well as fish crib deployment.

The Harmony Grove Lake Protection and Rehabilitation District recently received a Lake Planning Grant to conduct a sediment study on the sediment in the bay. Harmony Grove Bay is located on the Columbia County side of Lake Wisconsin north of Pine Bluff.

Wisconsin Power & Light Company, owner of the Prairie Du Sac Dam, as part of the Federal Energy Regulatory Commission (FERC) relicensing process conducted water quality, algal, fisheries and sediment contaminant studies during 1992. Continuous dissolved oxygen monitoring at the dam tailrace showed the water quality standard of 5 mg/l was violated more than half of July, a good portion of August and a few days in September, 1992. The worst two-day period occurred July 27-28, when the maximum dissolved oxygen was 3.6 mg/l, the minimum 1.7 mg/l. The suggested cause of the problem is a combination of the existence of the dam and the high nutrient loads in the river. This leads to excessive algae growth in Lake Wisconsin. When the algae die off, they deplete oxygen near the dam. Nutrient loading can come from barnyard runoff and other forms of nonpoint source pollution. One dairy farmer has been found to have multiple manure discharges to the lake. These sources of pollution need to be addressed and curtailed to help improve the health of Lake Wisconsin. In addition, fluctuating water levels below the Dells and Prairie du Sac dams remain a major concern on the Wisconsin River. Fish passage at all dams on the Wisconsin River is important to the fish communities and the river ecosystem as a whole.

In addition, long term database studies are in progress to look at walleye and sturgeon reproduction. A no harvest 20-28” slot regulation is proposed to improve fishing for larger size walleye. Sturgeon harvest has been curtailed by implementing an alternating season size limit of 50” and 70”. The lake sturgeon resource in the lake and river both up and downstream needs to be carefully managed. This is a rare and long lived fish of which there are few remaining fisheries in North America. Efforts are underway to expand the fishery upstream to its original home range. Pollution had eliminated it upstream from the Kilbourn Dam at Wisconsin Dells. A significant shovelnose sturgeon fishery also can be found in the lower Wisconsin River below the Prairie du Sac dam. In addition, it is imperative to continue to monitor the walleye population.

RECOMMENDATIONS (LW19)

- The development of a single lake management district or lake association to address all environmental issues related to **Lake Wisconsin** should be encouraged. This association could apply for grants to address the lake's water quality condition and the impacts of continued intense development around the lake.

- The Federal Energy Regulatory Commission license for the Prairie du Sac, Castle Rock and Pentenwell dams need to be completed.

- As part of the Federal Energy Regulatory Commission relicensing process that Wisconsin Power & Light Company conducts, it is recommended that additional monitoring be conducted to better define the extent of low dissolved oxygen levels upstream and downstream of the **Prairie du Sac dam**.

- As part of the Federal Energy Regulatory Commission relicensing process, Wisconsin Power & Light Company should develop and implement methods to raise the levels of dissolved oxygen in the vicinity of the **Prairie du Sac dam** during critical times.

- An assessment should be conducted to determine the impacts of the Poynette wastewater treatment plant on the water quality of **Rowan Creek**.

- Condition monitoring on **Hinkson, Rowan and Spring creeks** should be conducted as a part of the baseline monitoring effort.

- WRM should continue to conduct monitoring for the presence of toxic substances in fish in **Lake Wisconsin**.

- The **Rowan Creek** sub-watershed should be considered for possible selection as a Targeted Runoff Management project, (TRM), or other nonpoint source pollution reduction project.

- Stormwater management problems in the watershed should be assessed. Those municipalities in the watershed that do not currently have a stormwater control management plan and ordinance should develop and enact one.

- Municipalities in the watershed should examine the possibility of enacting new zoning laws to prohibit excessive development along **Spring Creek, Rowan Creek** and the **Lake Wisconsin** shoreline.

- The City of Lodi and the Wisconsin WDNR should conduct further habitat work along **Spring Creek** on Village park lands.

- Wisconsin Power & Light and the WDNR should conduct a study to examine fluctuating water levels below the Dells and Prairie du Sac dams.

- Walleye and sturgeon reproduction on **Lake Wisconsin** should continue to be monitored.

- A no harvest 20-28” slot regulation on **Lake Wisconsin** should be considered to improve fishing for larger size walleye.

- Devils Head Lodge and Merrimac should consider constructing new WWTP’s.

- **Parfrey’s Glen Creek** should be surveyed to determine if rare aquatic elements previously found in the streams are still present.

- Chemical sampling at the Wisconsin Dells Dam should be done to determine the phosphorus loading to the **Lower Wisconsin River**.

- Aquatic habitat in Gruber’s Grove Bay, **Lake Wisconsin**, should be restored.

- Continue instream habitat work on Manley and Lodi Creeks.

Recommendations adapted from the Dane County Water Quality Plan 1995

- Adopt erosion/runoff control ordinance consistent with Chapter 14 of Dane County Code of Ordinances. Incorporate requirement or revise building ordinances, to require roof drainage to grassed areas, where feasible, for new development.

- Develop a wellhead protection program for municipal wells.

- Evaluate use of deicers for potential groundwater quality impacts. Adopt written salt use management policy.

Watershed map

Streams in the Lake Wisconsin Watershed (LW19) — Columbia, Dane and Sauk Counties — Area: 199.5 sq miles

Stream Name	WBIC	Length (miles)	Existing Use	Potential Use	Supporting Potential Use	Codified Use and Trout Stream Classification	Proposed Codified Use	303(d) Status	Rare Aquatic Species	Use Impairment Source	Use Impairment Impact	NPS Rank	Monitored/ Evaluated/ Unassessed	Data Level	Trend	Ref.*
Hinkson Creek	1263900	4	COLD II	same	Part	COLD II	same	N	N	PSI, BDAM	HAB, TEMP	NR	M (1998)	B2, H2	U	5, 7, 23
Manley Creek	1261200	2.5	COLD I	same	Full	DEF	COLD I/ERW	N	N	BDAM	HAB, TEMP	NR	M	B2	I	6, 18, 23
Parfrey's Glen Cr.	1261100	0-4.9	WWSF	same	Part	DEF	same	N	Y	HM, BDAM	HAB, TEMP	NR	M (1993)	P1, B2	U	7, 23
		4.9-6	COLD I	same	Full	COLD I/ORW	same	N							U	
Prentice Creek (Durward's Glen)	1262600	0-4	COLD III	COLD II (0-7)	Part	COLD III	same	N	N	PSB,SB,CL	HAB	NR	E		U	5, 7, 23
		4-9	COLD I	same	Full	COLD I/ERW	same	N							U	
Rowan Creek	1263700	0-4	WWSF	same	Full	DEF	same	N	N	NPS, PSM	HAB	NR	M (1998)	B2, H2	U	5, 7, 14, 23
		4-12	COLD II	same	Full	COLD II	same	Y		PSM, BDAM, DEV, URB	HAB, TEMP				U	
		12-16	COLD I	same	Full-thr	COLD I/ERW	same	N		CL, BY	HAB				U	
Spring Creek (Lodi Creek)	1261900	0-7	COLD II	same	Part	COLD II (1-7)	COLD II (0-7)	N	N	NPS,PSI, PSM, URB, HM, BDAM, PSB, CL	HAB, TEMP	NR	M (2000)	B2, H2	U	5, 7, 8, 18, 19, 20, 23
		7-11	COLD II	same	Full-thr	COLD II/ERW	same	N							U	
Unnamed streams		47				DEF										

Total Stream Miles	95.5
COLD I	12.6
COLD II	23
COLD III	4
WWSF	8.9
U	47

The numbers in this column refer to the References found in the corresponding Watershed Narrative.
See Appendix J: "How to Read the Stream Tables," in Chapter 7 of the State of the Lower Wisconsin River Basin Report.

Lakes in the Lake Wisconsin Watershed (LW19) — Columbia, Dane and Sauk Counties

Lake Name	WBIC	County	Surface Area (Acres)	Max Depth	Lake Type	Winterkill	Access	SH	Hg	MAC	LMO	TSI	Lake Plan or Prot	P Sens	Comments
Pickerel Lake	1011600	Columbia	25	5										2	
Wisconsin Lake	1260600	Columbia	9,000	39	DG	N	BF, BR, P	C	M	EWM	DIST		PLAN	2	

See Appendix K: "How to Read the Lake Tables," in Chapter 7 of the Lower Wisconsin State of the Basin Report.

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Storm Sewers

The Rivers Beneath Our Feet

A SERIES OF WATER QUALITY FACT SHEETS ABOUT STORMWATER RUNOFF

If you look in the street outside of your home or office and search the parking lots around town, you will probably find storm sewer inlets. Did you ever wonder where they go?

A common misconception about storm sewers is that they go to a wastewater treatment plant. This is not the case. Storm sewers transport stormwater (rain and melting snow) to the nearest river, lake, stream or wetland.

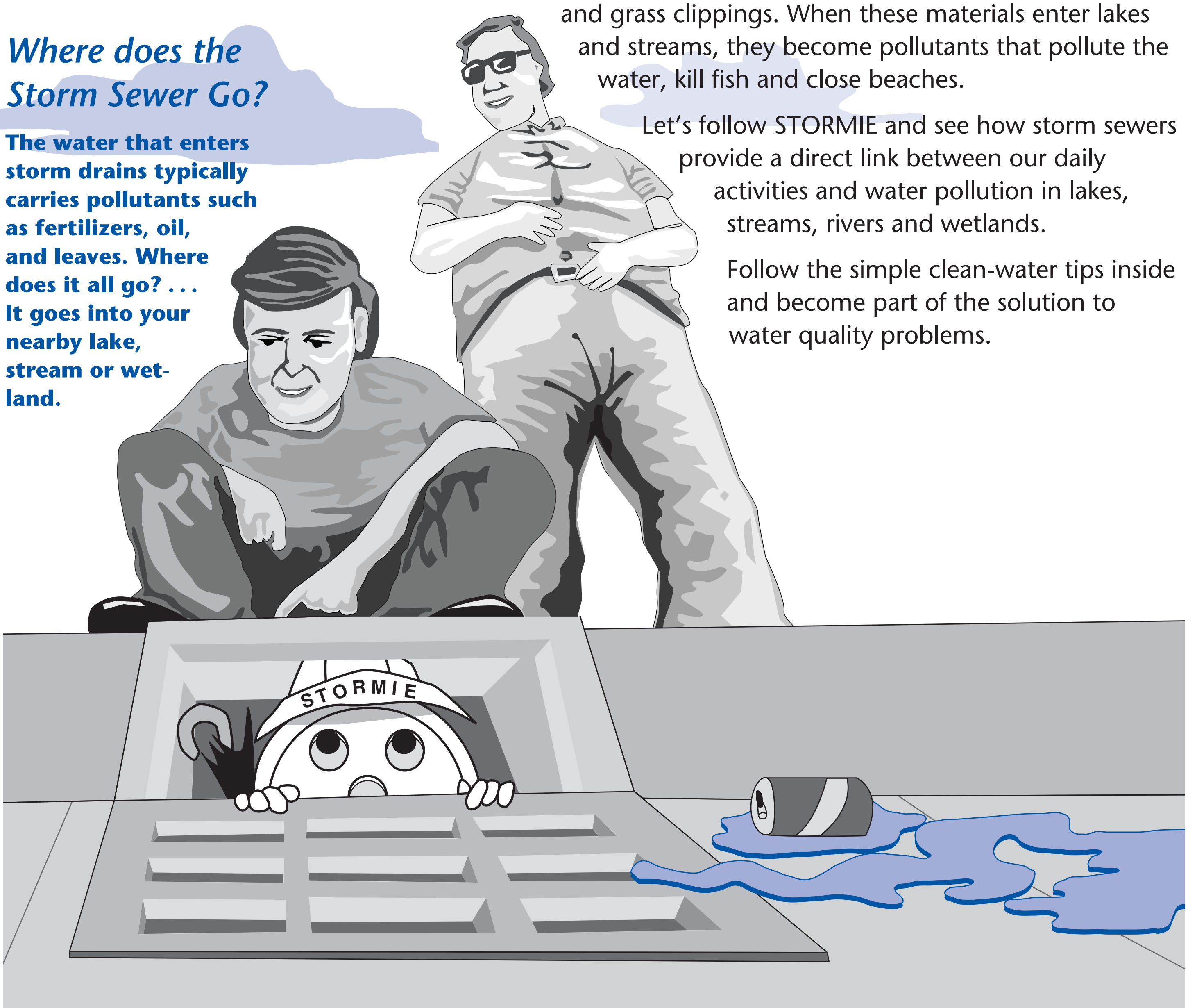
Stormwater often contains materials found on streets and parking lots such as oil, antifreeze, gasoline, soil, litter, pet wastes, fertilizers, pesticides, leaves and grass clippings. When these materials enter lakes and streams, they become pollutants that pollute the water, kill fish and close beaches.

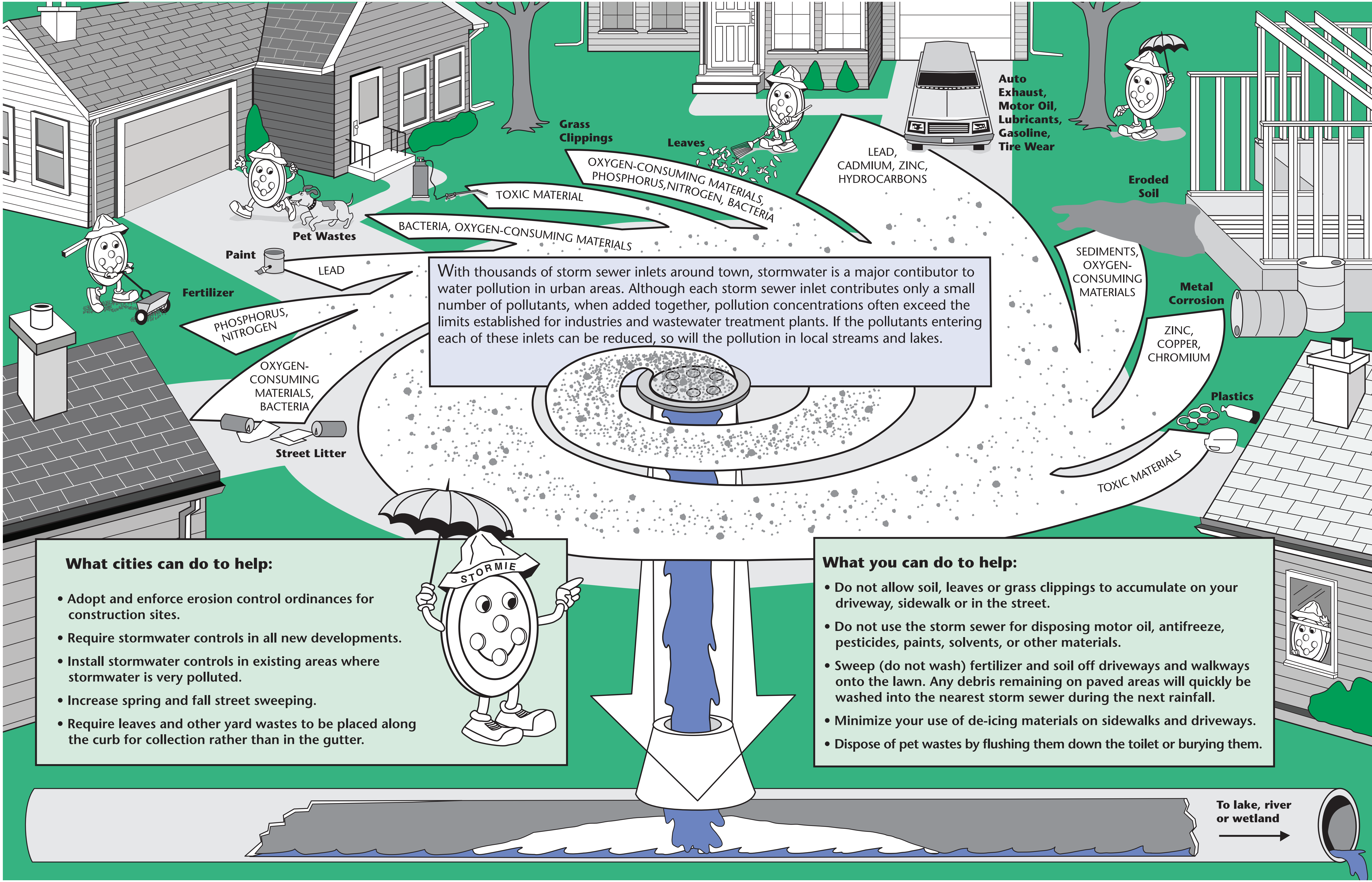
Let's follow STORMIE and see how storm sewers provide a direct link between our daily activities and water pollution in lakes, streams, rivers and wetlands.

Follow the simple clean-water tips inside and become part of the solution to water quality problems.

Where does the Storm Sewer Go?

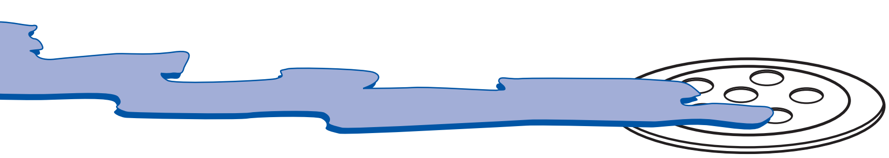
The water that enters storm drains typically carries pollutants such as fertilizers, oil, and leaves. Where does it all go? . . . It goes into your nearby lake, stream or wetland.




Grass Clippings
Leaves
Auto Exhaust, Motor Oil, Lubricants, Gasoline, Tire Wear
OXYGEN-CONSUMING MATERIALS, PHOSPHORUS, NITROGEN, BACTERIA
LEAD, CADMIUM, ZINC, HYDROCARBONS
TOXIC MATERIAL
BACTERIA, OXYGEN-CONSUMING MATERIALS
Pet Wastes
Paint
LEAD
Fertilizer
PHOSPHORUS, NITROGEN
OXYGEN-CONSUMING MATERIALS, BACTERIA
Street Litter
Eroded Soil
SEDIMENTS, OXYGEN-CONSUMING MATERIALS
Metal Corrosion
ZINC, COPPER, CHROMIUM
Plastics
TOXIC MATERIALS
With thousands of storm sewer inlets around town, stormwater is a major contibutor to water pollution in urban areas. Although each storm sewer inlet contributes only a small number of pollutants, when added together, pollution concentrations often exceed the limits established for industries and wastewater treatment plants. If the pollutants entering each of these inlets can be reduced, so will the pollution in local streams and lakes.
STORMIE
What cities can do to help:
• Adopt and enforce erosion control ordinances for construction sites.
• Require stormwater controls in all new developments.
• Install stormwater controls in existing areas where stormwater is very polluted.
• Increase spring and fall street sweeping.
• Require leaves and other yard wastes to be placed along the curb for collection rather than in the gutter.
What you can do to help:
• Do not allow soil, leaves or grass clippings to accumulate on your driveway, sidewalk or in the street.
• Do not use the storm sewer for disposing motor oil, antifreeze, pesticides, paints, solvents, or other materials.
• Sweep (do not wash) fertilizer and soil off driveways and walkways onto the lawn. Any debris remaining on paved areas will quickly be washed into the nearest storm sewer during the next rainfall.
• Minimize your use of de-icing materials on sidewalks and driveways.
• Dispose of pet wastes by flushing them down the toilet or burying them.
To lake, river or wetland

According to federal regulations, many cities and industries must reduce water pollution from storm sewers. We can help by taking steps around the home to increase the amount of water that soaks into the ground. This reduces the amount of water flowing into the street. Here's what you can do:

- ✔ Plant trees, shrubs or ground covers.
- ✔ Maintain a healthy lawn.
- ✔ Redirect down spouts from paved areas to vegetated areas.
- ✔ Install gravel trenches along driveways or patios.
- ✔ Use porous materials such as wooden planks or bricks for walkways and patios.
- ✔ If building a new home, have the driveway and walkways graded so water flows onto lawn areas.
- ✔ Use a rain barrel to catch and store water for gardens.
- ✔ Wash your car on the lawn, not the driveway, or take your car to a commercial car wash.



For more information about stormwater pollution and what you can do to reduce it, contact the Department of Natural Resources or your county UW-Extension or Land Conservation office.

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UW Extension

WISCONSIN DEPT. OF NATURAL RESOURCES

GWQ004 Storm Sewers – The Rivers Beneath Our Feet

DNR WR-460-94

R-09-99-15M-25-S

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.

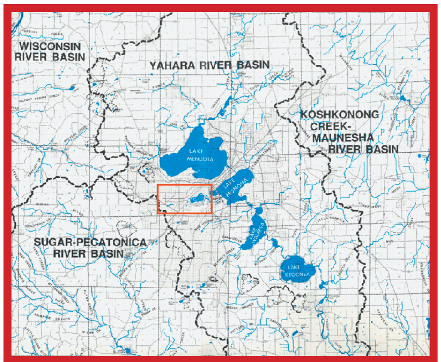
Storm water is not a new concern for human cultures. Ancient Roman and Greek civilizations built roadways that slanted towards ditches to direct storm water off the streets. The Romans also built curbs and gutters to direct water. Some of these Roman storm water structures are still in use today. For 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.

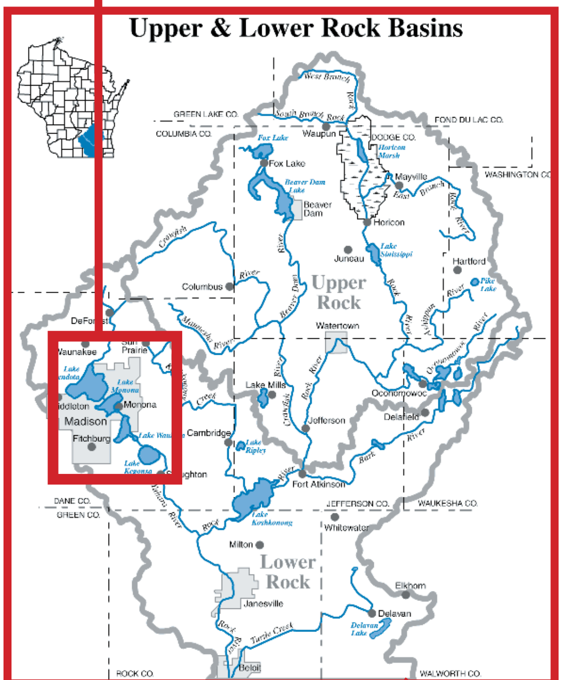
Before discussing issues, impacts, and solutions concerning storm water, some broader concepts will be defined such as what is a watershed, how is it related to the larger water cycle and how does land use affect the dynamics of water and land in the watershed.

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 Student Resources section to find your watershed and some of the activities happening in it.

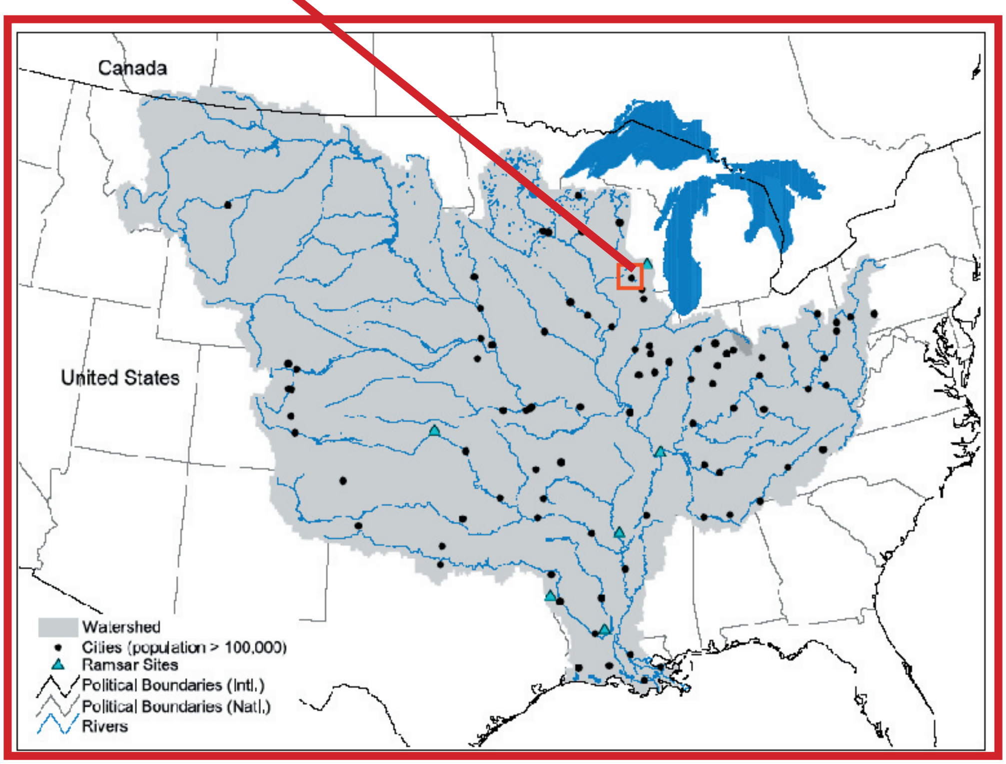


Figure 2: The Yahara Watershed fits inside the Rock River Basin, which fits in the Mississippi Basin. Source Dane County/UW Extension.

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.

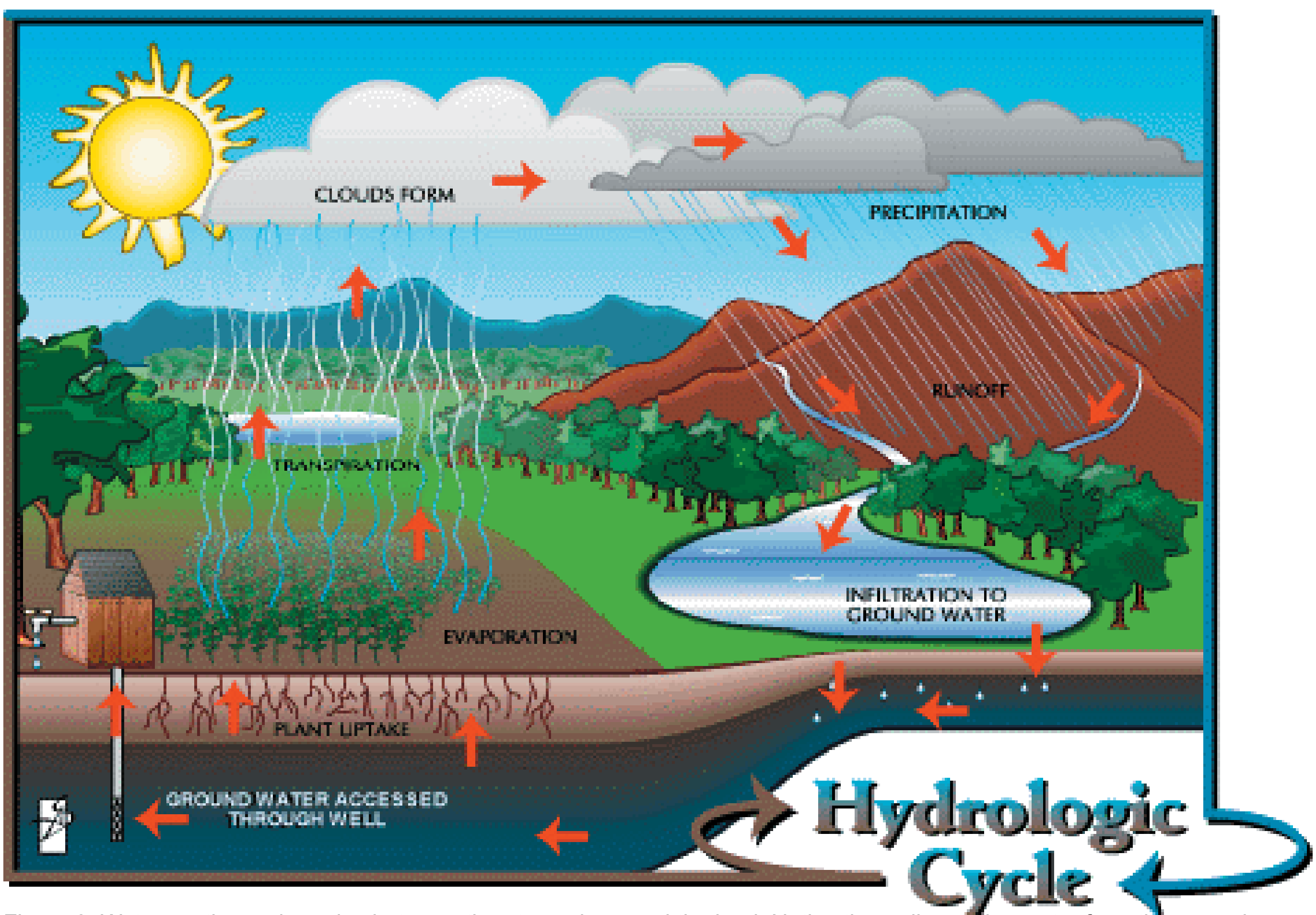


Figure 3: Water continuously cycles between the atmosphere and the land. Notice the well pumping water from the ground. What do you think happens when more water is pumped from the ground and empties outside the local watershed? Source US EPA.

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.

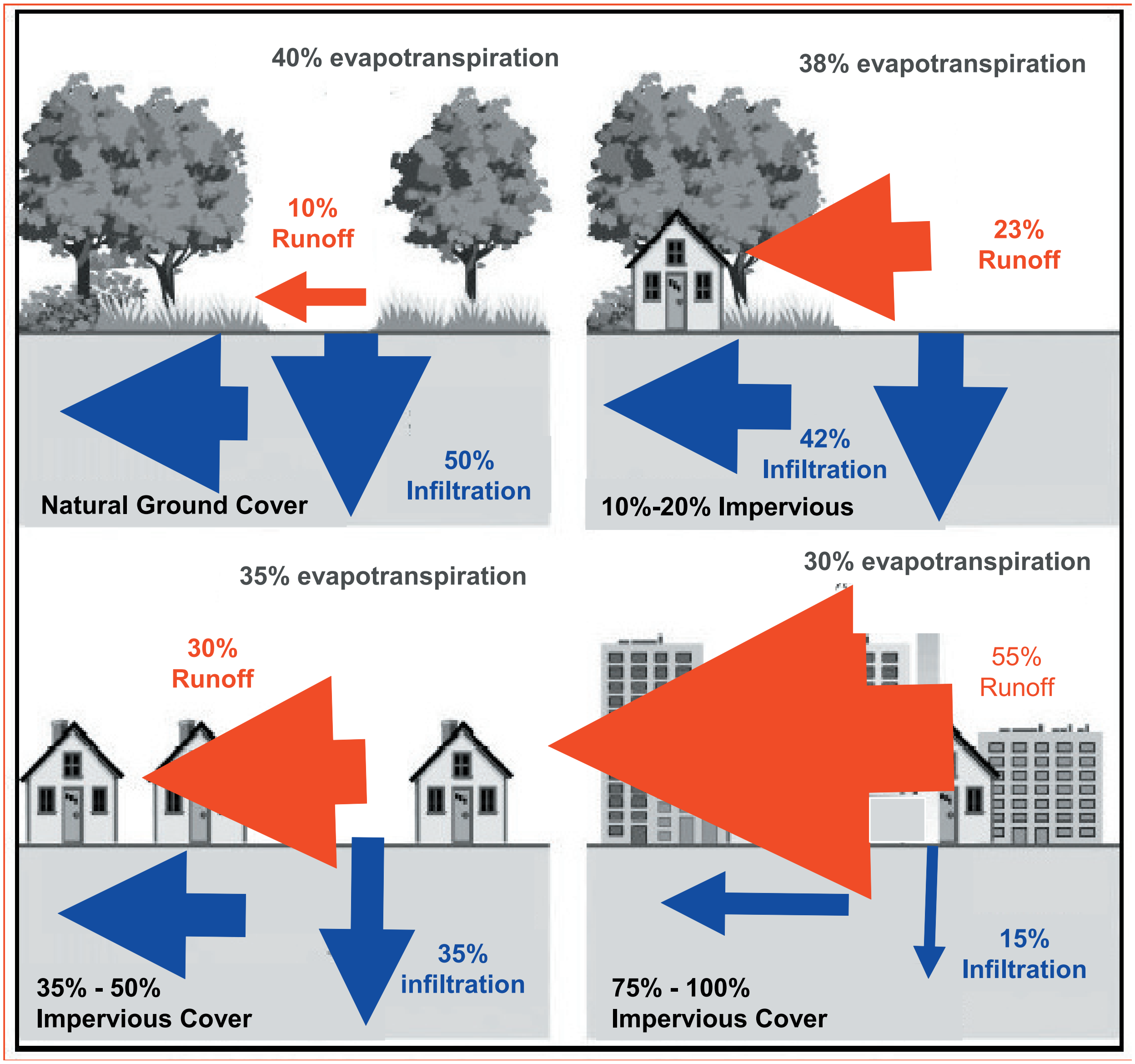


Figure 4: Relationship between impervious cover and surface water runoff. All other processes are reduced as surface runoff increases. Can you guess why increased impervious surfaces reduce evapotranspiration? Illustration from: Federal Interagency SRWG.

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.

<u>**Environmental Concerns**</u>
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.

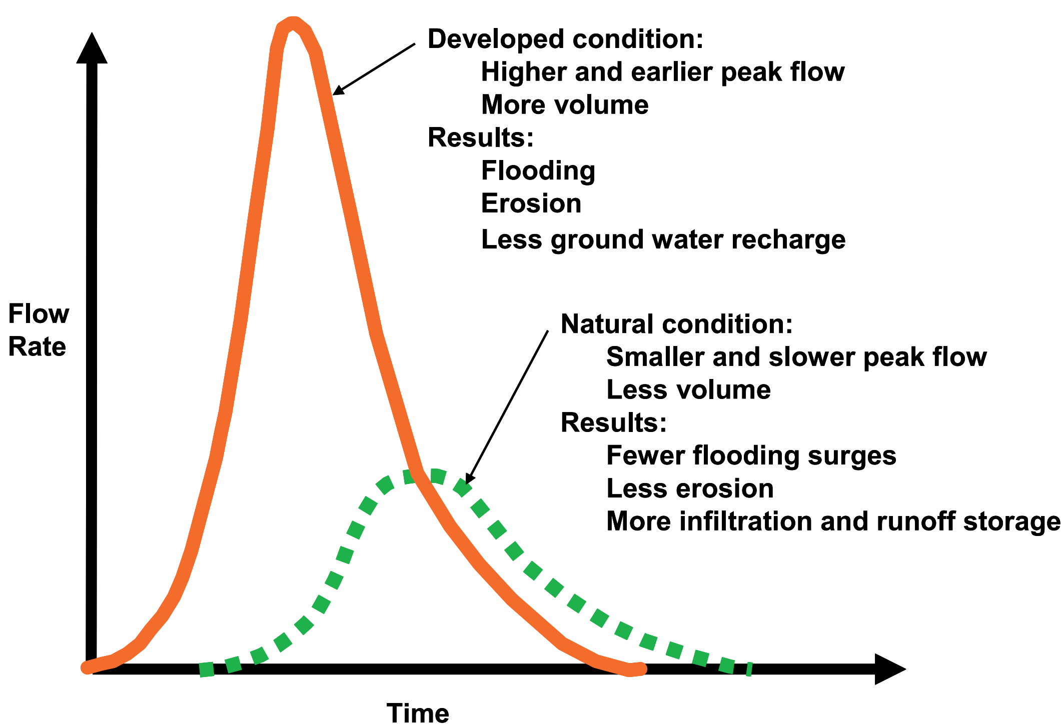


Figure 5: This hydrograph compares storm water flow between developed and undeveloped land. Notice the increase of storm water and how quickly it begins moving on the developed land. Adapted from Wisconsin Rain Garden Educator's Kit, University of Wisconsin Extension & Wisconsin Department of Natural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

<u>Economic Concerns</u>

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 <u>Resources for Students</u> 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

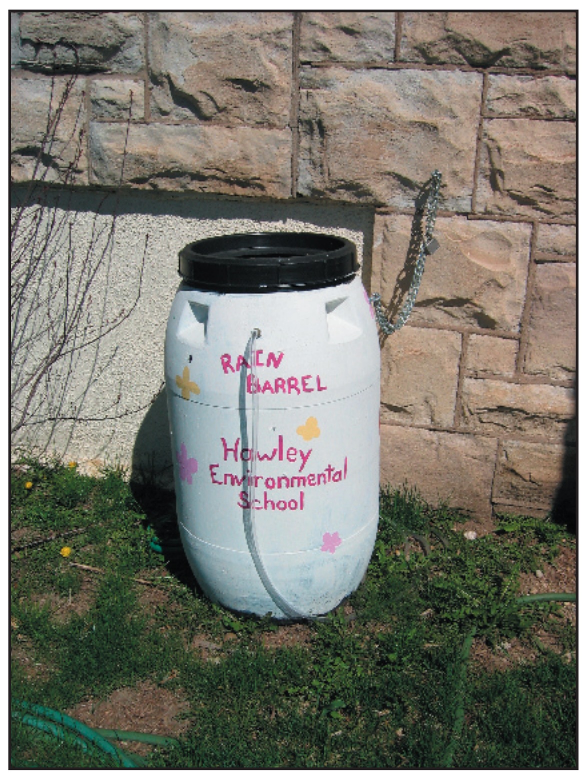


Figure 11: Rain barrels located at downspouts can catch water and slowly release it or save water for irrigation. Students at Hawley Environmental School, Milwaukee, WI, built this rain barrel. Source Cheryl Bauer-Armstrong.

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.

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.

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.

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.