



Controlling Runoff and Erosion
From Your Waterfront Property
A Guide for Burnett County Landowners

Table of Contents

Introduction	1
What To Do On Your Lot	2
Minimize Hard Surfaces	3
Vegetate.....	4
Divert	5
Grading.....	5
Berms.....	5
Drain Tile.....	6
Channels.....	6
Driveways and Path Diversions.....	7
Roof Gutters and Downspouts.....	9
Drop Pipe	10
Infiltrate	11
Measuring Infiltration Rates.....	11
Leveling Infiltration Areas.....	11
Rock Infiltration Trenches	12
Rock Infiltration Pits.....	13
Rain Gardens.....	14
Maintain an Ice Ridge.....	16
Additional Resources for More Information	17

Introduction

This booklet provides practical guidance for controlling runoff and reducing erosion from your waterfront property. The information focuses on reducing erosion caused by runoff that flows from your property to the water. It does not address erosion caused by waves against the shoreline.

The manual was developed for waterfront property owners in Burnett County, Wisconsin. Burnett County is located mostly in the Sand Barrens of Northwest Wisconsin. The county's sandy soils erode easily – especially when vegetation is removed. On a more positive note, sandy soils also provide great opportunities for reducing erosion by encouraging infiltration - allowing runoff water to soak into the soil.

A Few Definitions

Runoff is the portion of the rain and snow falling on the surface of the earth that doesn't soak into the soil and ultimately flows to lakes and streams. Runoff frequently picks up and carries pollutants as it travels across impervious areas.

Impervious areas are hard, non-porous surfaces like roofs, paved driveways, and cement sidewalks. Impervious areas do not allow water to infiltrate.

Infiltration is when water soaks into the soil.

Erosion is the wearing away or loss of soil particles. Erosion is caused when soil particles are dislodged by water falling on or running across bare soil. Soil particles are carried by runoff and finally deposited in a lake or a stream, or sometimes in a resting place along the way.

Additional definitions are found in italics throughout the booklet.

Impacts of Erosion

Erosion on waterfront property can be a serious problem both for the property owner and the lake or river ecosystem. Gullies or large eroded channels are unsightly. They may result in loss of depth of water frontage when soil flows to the lake. It is usually cheaper and easier to prevent rather than repair erosion problems.

Soil deposited in the water carries nutrients including phosphorus, the nutrient that triggers algae blooms in most Wisconsin lakes. Sediments also bury fish and wildlife habitat such as walleye spawning beds.

Erosion of sediment to lakes and rivers is especially problematic during construction activities. Erosion rates from construction sites where soil is bare and runoff is uncontrolled can be up to 1000 times greater than a naturally vegetated site. A one-acre naturally vegetated site may lose about .2 tons or 400 pounds of sediment each year. An unprotected one-acre construction site may lose 200 tons or 400,000 pounds of soil each year. Erosion is of particular concern when it occurs near lakes and rivers because that's where the sediment and nutrients end up.

Impervious surfaces like roofs and driveways can make the problem worse because they don't allow water to soak into the ground creating more runoff. The increased amount of runoff water has additional force to erode soil, which may create gullies like the one shown below.

Problems Resulting from Erosion

- Unsightly gullies and loss of property
- Pollutants carried to the lake or stream
- Loss of fish and wildlife habitat



What to do on your lot

Assess the Problem

Look for areas where erosion is occurring. Runoff water is likely the cause of erosion. Right after a big rainstorm is the perfect time to look at erosion patterns. Can you see the pathway of water flow? Are leaves and pine needles or groundcover vegetation removed by flowing water? Follow the path of water uphill to its source. Is a channel created by runoff from a roof, driveway, road, or other hard surface? Don't ignore small channels and eroded areas. These spots frequently turn into bigger problems. Erosion that you identify may get worse if you increase the hard surfaces on your lot or if you experience a lot of rain in a short period of time.

Develop a Base Map

You can do a better job assessing your erosion problem and developing solutions with a base map of your property. Start by drawing a map that shows your entire property to scale. Include structures like your house, garage, sheds, pathways, and paved areas. Also consider

uphill areas that drain to your property from a road or your neighbor's property. Look at the direction of water flow during or after a large rain event and add arrows to illustrate the flow on the map. The eroded areas or gullies identified above also give you clues for placing flow arrows. The base map will be a useful tool as you begin to figure out solutions to your erosion problems.

Figure out a Solution

The next step to controlling runoff is to investigate and select options to minimize, divert, and infiltrate runoff water. Each lot is unique. A variety of tools may be needed to address the problem. If erosion problems are minor, start with simple practices like planting native vegetation and diverting water to relatively flat areas with good vegetative cover. Severe erosion will probably require more complex, structural practices. If the practices you have installed don't work the first time, don't give up. Reconsider patterns of water flow and erosion and adjust your plan of action.

Concepts and tools to consider are described on following pages. A combination of diversion and infiltration of water is generally needed, and may need to be installed both above and below buildings. The drawings in this handout are conceptual and the suggestions are general. Seek professional assistance from an engineering firm or the Land and Water Conservation Department for more detailed recommendations.

Minimize hard surfaces

Hard surfaces and buildings prevent water from soaking into the ground, increasing runoff and erosion. To minimize these nonporous (or impervious) surfaces:

- Use gravel instead of pavement for driveways and sidewalks
- Install stepping stones for a pathway instead of using concrete
- Avoid compacting soil with heavy equipment. It may take many years for natural processes to restore infiltration rates.
- When developing adjacent properties, design development with shared driveways and roads.
- Think small. A structure that covers less surface area will have less of an impact on your lake ecosystem.
- Use porous paving materials.

Porous paving materials are concrete or asphalt blocks with openings or plastic mesh that can be filled with gravel, sand, or soil and sometimes planted with vegetation. Porous paving materials allow water to soak into the soil.

BEFORE BEGINNING A PROJECT IN THE SHORELAND ZONE

- Check local and state permitting requirements (Burnett County Zoning: 715-349-2138)
- Call diggers hotline before excavating (1-800-242-8511 or diggershotline.com in WI)
- Install temporary erosion control measure, such as silt fence, downhill from the area to be disturbed. This will prevent sediment from entering the water during construction.
- Have a plan to revegetate disturbed areas as quickly as possible

Vegetate

Vegetation helps to reduce erosion by covering the soil, cushioning the impact of raindrops, and slowing runoff water flow. Each layer of vegetation provides particular benefits.

Trees and Shrubs

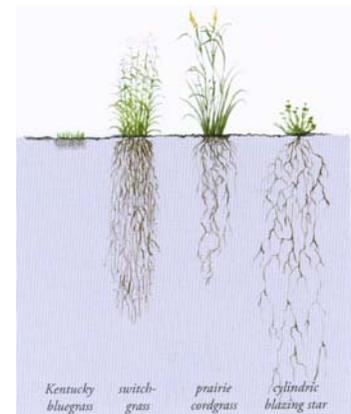
- Cushion the force of raindrops
- Hold rainwater on leaves and branches
- Roots keep soil in place

Grasses and Groundcovers

- Slow runoff flow
- Filter pollutants
- Allow water to soak in along root channels

Duff Layer (leaves, small branches, and pine needles)

- Covers soil
- Slows runoff flow
- Allows water to soak in



Deep-rooted native shoreline plants stabilize banks and help minimize erosion. Kentucky bluegrass on the far left is a nonnative, common turf grass.
Drawing used with permission of MN DNR

Many resources provide guidance for re-vegetation with native plants. A few are listed on the last page of this handout.

Where vegetation doesn't work to stabilize the soil entirely, additional runoff and erosion control measures may be necessary.

Divert

Divert means to re-direct runoff water.

Runoff should be diverted to a flat area that is well-vegetated with grasses and groundcovers and/or to where the soil is covered with a thick duff layer. Another option is to divert runoff to an infiltration practice as described beginning on page 11. A variety of techniques are available to divert runoff water.

IMPORTANT REMINDER

Do not transfer problems by diverting water to your neighbor's property! You may need to work together with several neighbors to solve a runoff problem.

Grading

On some properties the best way to avoid runoff problems is to grade or slope the land away from the lake. This is an especially useful technique to consider before undertaking a construction project. Keep in mind that heavy equipment may compact the soil and discourage infiltration. Slope driveways, sidewalks, and other nonporous surfaces so they drain away from the lake or river. Avoid sloping toward a house or septic drain field.

Berms

Berms are small mounds of earth about 6 to 12 inches high.

Berms can be used to direct small amounts of water across a slope or to capture water for drainage to a pipe or infiltration practice. A berm across the top of a slope in very sandy soils will encourage infiltration and prevent erosion along the hillside.

Use berms only on gradual slopes (less than 10 percent). A ten percent slope increases (or decreases) in elevation 10 feet vertically for every 100 feet horizontally as illustrated on the next page.

DETERMINING SLOPE

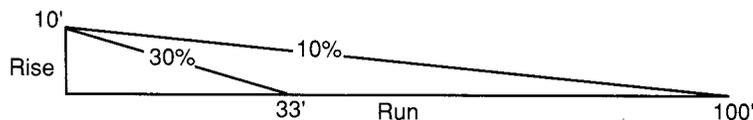


Figure 1: $\text{Slope \%} = \text{Rise} / \text{Run} \times 100$

Keep the slopes of the berm gradual. A 4 to 1 slope (four feet horizontal for every one foot vertical) or even more gradual slope is best. Revegetate the berm immediately by seeding with a perennial grass in combination with a quickly germinating annual grass. See recommended seeding rates for annual grasses in the box below. Staking erosion control netting in place over the seeding is recommended. The Burnett County Land and Water Conservation Department has rolls of 180 square feet of erosion control netting available for sale.

Seeding rates for quick stabilization*	
Annual rye:	0.5 – 1 lb
Oats:	0.5 – 1 lb
Canada wild rye:	1 oz.
*All rates are per 1000 ft ²	

Drain Tile

Drain tile is perforated HDPE (high density polyethylene) or corrugated plastic pipe. The perforations disperse water as it flows along the length of the pipe.

Drain tile is used in many applications to direct and disperse water. For example, drain tile attached to rain gutter downspouts can be buried to disperse water underground, and come back to the surface to release the remaining water in a well-vegetated area. Drain tile is also frequently used around a basement to divert water away from the interior of the house.

A 4-6 inch diameter drain tile is generally appropriate for single-lot use. The pipe can be buried at least one foot to prevent freezing and compaction. Surround the drain tile in a bed of ¾ inch to 2-inch diameter rock to encourage infiltration of the water flowing through the pipe.

Channels

Channels are depressions or ditches created to carry water to a desired area.

Channels are generally used where water flow is heavy enough to wash out an earthen berm or where a ditch is more desirable for visual or practical reasons. Because channels are exposed, they are easier to maintain than pipes. Water directed in a channel across a slope, rather than down slope, will flow more slowly and prevent erosion. Two channel configurations are shown in Figures 2 and 3 on the following page.

Channels can generally be lined with grass where downhill slopes do not exceed four percent and the impervious area that drains to the channel does not exceed 2 acres (90,000 sq. ft.). Remember to consider all areas that flow to the channel in this calculation - both on and off your lot. Stabilize the channel by revegetating any bare areas immediately

after construction. Seeding with annual and perennial grasses followed by installation of erosion control netting is recommended.

Where there are larger drainage areas or steeper slopes, it may be necessary to reinforce the channel with rock. A permit may be required to install rock. Install filter fabric beneath rock to keep underlying soil from working its way to the surface. Avoid placing rock in the shoreland setback area (within 75 to 100 feet back from the ordinary high water mark in Burnett County).

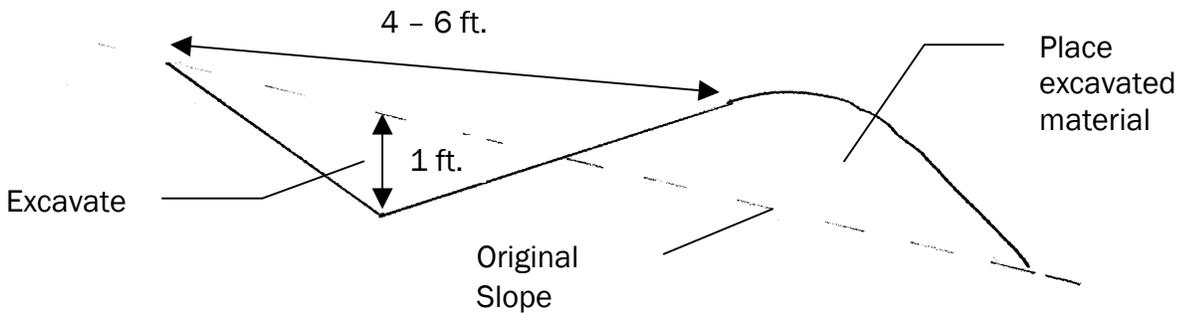


Figure 2 : V-Shaped Channel (side view)

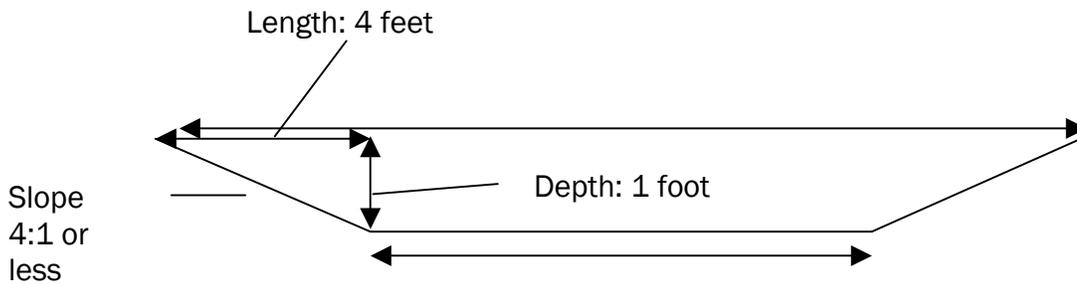


Figure 3: Grassed Waterway (side view)

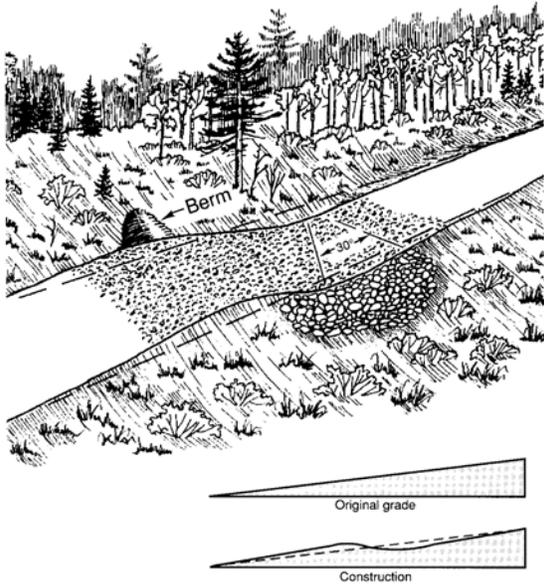
Driveway and Path Diversions

Erosion frequently occurs along driveways and paths to the lake, especially where slopes are steep. Broad-based dips and water bars placed to divert water at intervals along a driveway or pathway slope will minimize erosion downhill. These diversions must be directed to a well-vegetated area or designed infiltration area to prevent further erosion. Driveway grades should not exceed ten percent.

Driveway or pathway broad-based dips or water bars recommended placement interval for one-foot depth is shown in Table 1 on page 9. Drainage across pathways might be

constructed at more frequent intervals with more shallow water bars or dips. For example, place path water bars three times closer together and four inches deep across pathways.

Broad-based dips are depressions covered with gravel that divert water across the slope of the driveway.

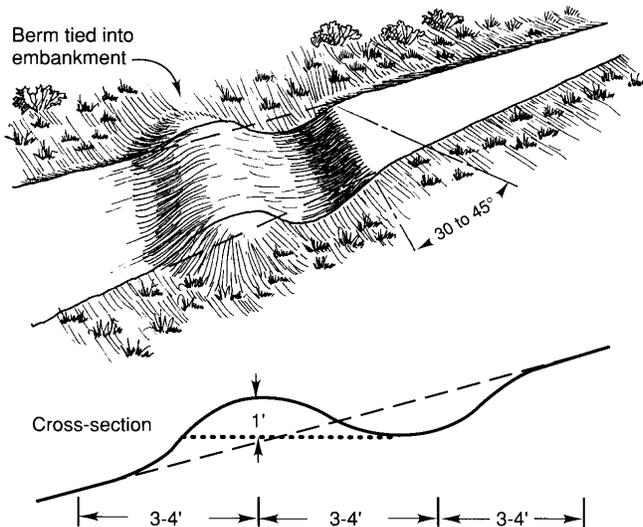


- ✓ Construct broad-based dips deeply enough to provide adequate drainage and at least the width of the driveway to allow vehicles to pass safely.
- ✓ Dips should angle downhill at about 30 degrees.
- ✓ Place a surface of crushed stone or gravel on the dip.

Figure 3: Broad-Based Dip

Broad-based dip cross-section

A water bar is a shallow trench with a mound (or berm) to intercept runoff water and provide cross drainage.



- ✓ Place water bars angled 30 to 45 degrees downhill with a slope of about 2 percent across the driveway.
- ✓ Water bars for pathways can also be constructed with treated lumber by creating a channel between two planks.
- ✓ The slope of the driveway should determine the distance between water bars and broad based dips. See Table 1 for recommended placement.

Figure 4: Water Bars

Table 1. Recommended distances between drainage structures on driveways.

Percent slope	Distance between waterbars (feet)	Distance between broad-based dips (feet)
1	400	500
2	250	300
5	130	180
10	80	150
15	50	130
25+	40	110

Roof Rain Gutters and Downspouts

Runoff from roofs frequently creates erosion. In fact, many of the small gullies that lead to the lake begin where water falls from rooftops. To control water flow and alleviate this problem, install roof gutters and downspouts and spread or infiltrate the roof water.

Consider “self-cleaning” or enclosed gutters to prevent clogging from leaves, pine needles and other debris. Cleaning the roof gutters regularly will prevent clogging and keep the water leaving the downspout clean.

Roof gutters will not help to control erosion unless the outflow is managed properly. To effectively prevent erosion, the flow of the water from the downspout must be spread out, diverted to an infiltration area, or sent to a rain barrel. A by-pass to the infiltration or rain barrel diversion should be developed for overflow when rains are very heavy (see Figure 5 “surcharge pipe”).

Outflow Options

Spreaders

Plastic or concrete spreaders placed beneath downspouts will spread outflow in an attempt to produce sheet flow rather than channelized flow.

Drain tile

Drain tile will disperse water as it flows along the length of the pipe. Bury the drain tile as described on page 7 and outlet at a well-vegetated, flat area.

Infiltration pit or flat area

Send water to a well vegetated flat area or to an infiltration pit as shown in Figure 5 and described in more detail on page 13. The observation well is an optional feature included to check how quickly water is dissipating from the pit.

Rain barrels

Many styles of rain barrels are available commercially. A manually operated valve on a hose will allow the use of the water for lawn and garden. As an alternative, a small diameter hose near the base of the barrel will release water slowly. Cover the barrel to keep small children and animals safe and prevent mosquito breeding. Clean rain barrels at least once each year, and drain before winter.

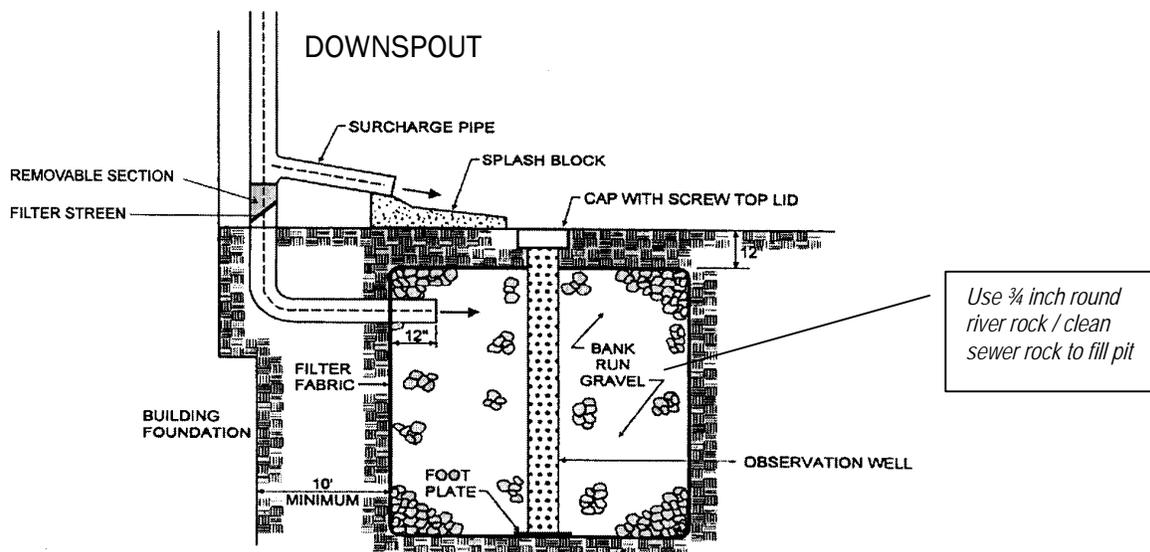


Figure 5. Roof infiltration pit

Drop Pipe

If erosion is severe and space for infiltration is limited, clean water, such as water from a roof, may be piped to outlet at the lake. The outlet may need to be reinforced with rock to avoid erosion at the end of the pipe. A Department of Natural Resources and/or County Zoning permit may be required.

Infiltrate

Infiltration practices hold runoff water in a flat area and allow water to soak into the soil. They work well where infiltration rates (speed that water soaks into the soil) range from 0.5 – 3 inches per hour. Sandy soils provide lots of opportunity for infiltration. Sites tested in Burnett County had infiltration rates as high as 25 inches per hour. Infiltration practices are not recommended where soils consist of more than 30 percent clay or more than 40 percent silt and clay. Soil test kits are available from the Burnett County UW-Extension Office (715-349-2151).

Measuring Infiltration Rates

You can perform a simple infiltration test by digging a hole one foot deep and filling it with water to moisten the soil. Allow this water to drain, then fill the hole again. Measure water depth after filling and every 15 minutes until the hole drains. Measured every fifteen minutes, the infiltration rate per hour is four times the average decrease in water depth.

Leveling Infiltration Areas

A 2X4 plank, carpenter's level, string, and stakes can be used to create a level bottom for an infiltration area.

- Place stakes at the uphill and downhill side of the infiltration pit, trench, or rain garden.
- Tie strings to stakes so the string is level.
- Check the levelness of the string with the carpenter's level, and adjust as needed.
- Dig to a desired depth from the string.
- Check bottom level at various locations and angles by placing the plank on the bottom surface and checking with the level.

Things to Keep in Mind When Infiltrating Water

- Place infiltration practices at least 10 feet from the house to prevent undermining of the foundation or seepage into the basement.
- Infiltration practices should be at least 50 feet from shallow drinking water wells.
- Be sure the bottom of an infiltration area is separated at least a few feet from the groundwater to prevent groundwater contamination.
- Avoid locating infiltration uphill of a septic drain field.

Rock Infiltration Trenches

Infiltration trenches are long, relatively shallow excavated areas, lined with filter fabric, then filled with rock.

Use a rock trench to capture runoff from a roof or parking area. A filter fabric trench liner prevents soil from entering the spaces between the rocks where water is held. Filter fabric is available from the Burnett County Land and Water Conservation Department (715-349-2186) and many hardware stores. Try to keep sediment out of the rocks at the top of the trench to maintain the pore spaces and extend the life of the trench.

Trenches may be constructed next to buildings without basements or foundations such as pole sheds. Do not place trenches next to a house where water could soak into the basement. Allow a fifteen-foot wide strip of grass between a parking area and a rock trench to clean the water before it soaks into the groundwater.

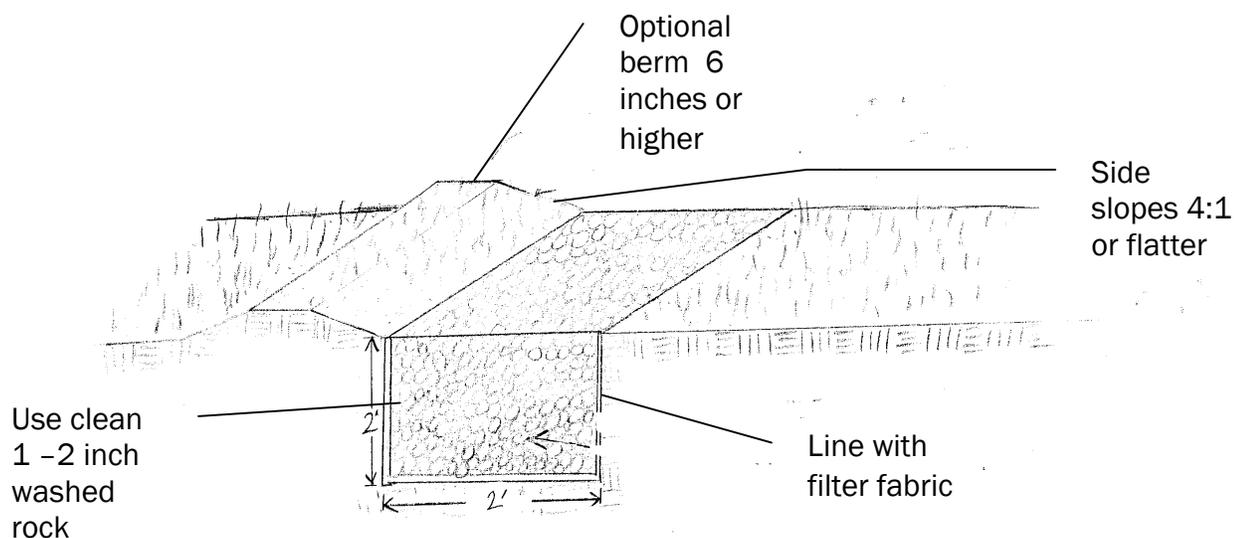


Figure 6. Rock Trench

Trench size depends upon the amount of water to be captured and the rate of infiltration of underlying soil. The space between the rocks holds water, which then soaks into the soil beneath the trench. A two-foot deep trench along a roofline will capture a significant volume of water. Table 2 below lists the length of trench necessary to capture a one-year, 24-hour storm event. These trenches will probably overflow with large storms. The edge where the overflow occurs should be made as level as possible to reduce the creation of channelized flow.

IMPORTANT NOTE: Sizing is for areas with sandy soils with drainage rate of at least 3 inches per hour.

Table 2: Sizing for rock trenches along roofs and parking areas.^{1, 2}

Area of hard surface (sq. ft.)	Length of 2 foot wide trench	Length of 3 foot wide trench
200	17	11
400	33.5	22
600	50	33.5
800	67	45
1000	84	56
1500	126	84
2000	167	112
2500	209	140
3000	251	168

- 1) trenches are all two feet deep
- 2) trenches are sized to capture a one year 24-hour storm event

Rock Infiltration Pits

An infiltration pit is constructed similarly to a trench, except that a pit is deeper, and a pit is designed to fit into available area. A 3-foot deep infiltration pit should be 5 - 10 percent of the size of the impervious surface that drains to it.¹ A 4-foot deep infiltration pit should be from 4 - 8 percent of the size of the impervious surface that drains to it. Do not construct a pit deeper than five feet because the soil beneath the pit will compact and drain more slowly.

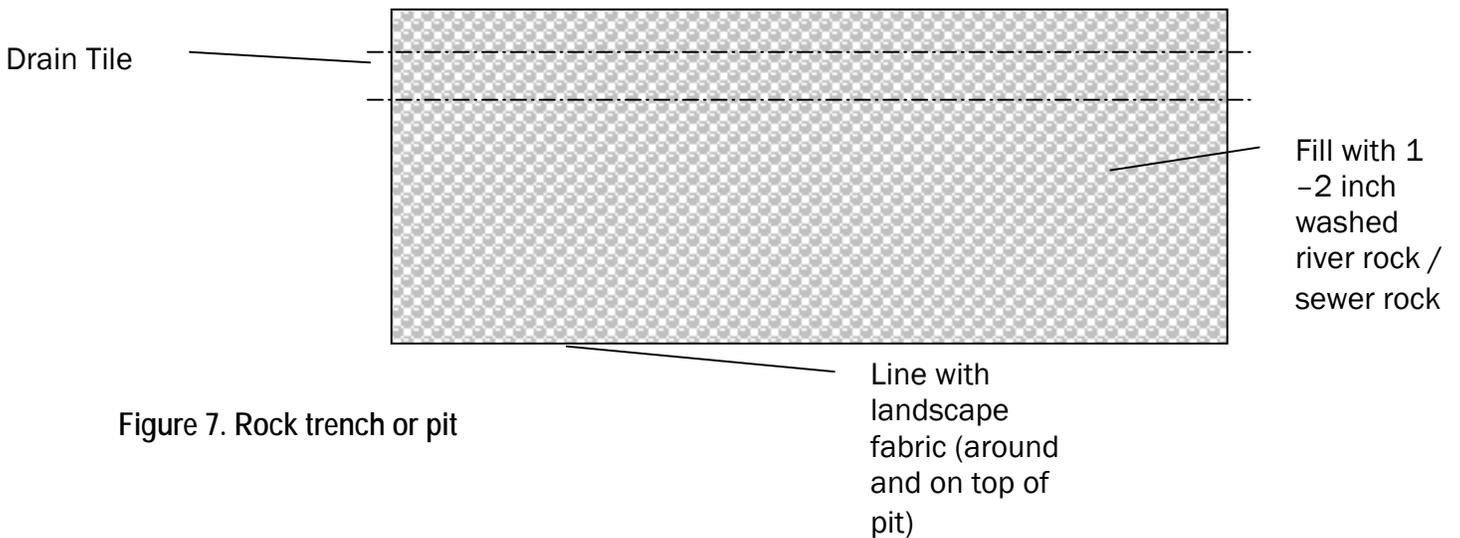


Figure 7. Rock trench or pit

¹ This will capture the runoff from a 1 year, 24-hour storm event to a 25 year, 24-hour storm event. In Burnett County this is equivalent to from 2.3 to 4.6 inches of rain in a 24-hour period.

Rain Gardens

A rain garden is a shallow depression planted with native grasses, flowers, and shrubs.

Rain garden plants are an attractive addition to the landscape. Their roots help to increase infiltration and absorption of water. Rain gardens are generally designed to drain within 24 to 48 hours.

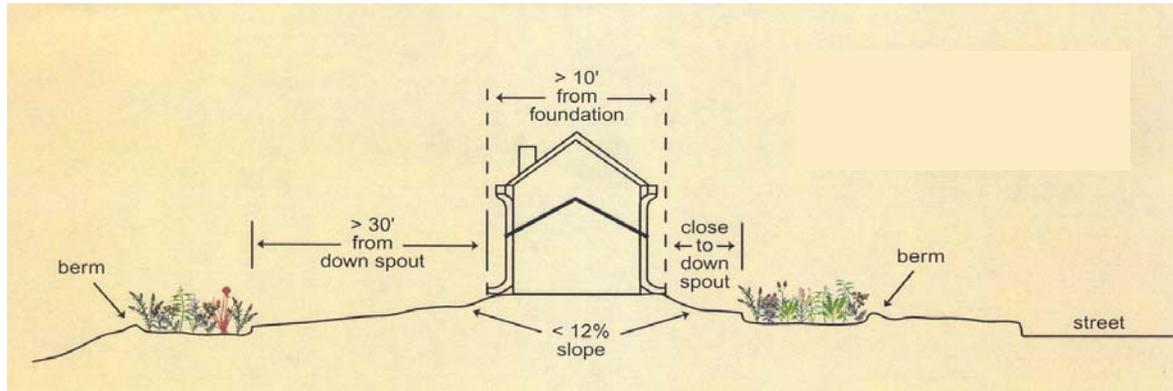


Figure 8. Rain Garden

The upstream side of the rain garden should be level to evenly spread the flow of water. Water should run through grasses before entering the rain garden. The bottom of the garden should be level so that the pool of water spreads across the entire area. The downstream side may be sloped gradually with a 3 to 1 or 4 to 1 slope.

Steps to complete a rain garden.

1. Install a silt fence down slope of where the garden will be constructed.
2. Excavate a shallow depression – 6-18 inches deep for sandy soil; 6-12 inches deep for loamy soil that drains less quickly.
3. Sizing depends on space available, depth of garden, and impervious surface area draining to the garden. Rain gardens generally range from 150 – 600 ft². A rule of thumb for sandy soil is to construct a garden that is 5-10 percent of the impervious (hard surface) area draining to it. Double the size for silty soils.
4. Remove remaining non-native vegetation with herbicide. A glyphosate herbicide like Roundup is recommended. Follow label instructions. Additional guidance for removing vegetation is found in Burnett County's *Shoreline Buffer Restoration: A Guide for Landowners*. Leave turf in place on upstream side.

5. Mulch area to be planted with 2 inches of wood chips or 3-4 inches of straw or leaves. You might also install a wood fiber erosion control blanket and plant seedlings through the blanket. Wood fiber (excelsior) blankets are available from the Burnett County Land and Water Conservation Department (715-349-2186).
6. Plant with native plants spaced 12-18 inches apart. The landowner guide provides detailed planting instructions. Choose plants adapted to the site that will tolerate short periods of standing water. Re-seed remaining disturbed areas with lawn grass. Assistance with plant selection is available through the Burnett County Land and Water Conservation Department.
7. Supplemental watering may be required during dry periods, especially to establish plants.
8. Remove weeds the first year.
9. Remove standing dead material in the spring (optional).

Plants for Rain Gardens in Sandy Soils

Grasses/Sedges

Big bluestem	<i>Andropogon gerardii</i>
Bluejoint grass	<i>Calamagrostis canadensis</i>
Indian grass	<i>Sorghastrum nutans</i>
Prairie cord grass	<i>Spartina pectinata</i>

Flowers

Black-eyed Susan	<i>Rudbeckia hirta</i>
Culver's root	<i>Veronicastrum virginianum</i>
Fireweed	<i>Epilobium angustifolium</i>
Wild bergamot	<i>Monarda fistulosa</i>

Links to additional info are found on page 17.

Maintain an Ice Ridge

An **ice ridge** is a ridge of soil and rocks that forms naturally from the force of ice pushing toward the shoreline.

An ice ridge is beneficial because runoff water will soak into the soil behind it. Many landowners remove the ice ridge after it forms because of its appearance and for ease of access to the lake. Removing the ice ridge is an on-going effort. While the ridge may not form each year, if it forms once, conditions are likely to occur again that will re-form the ridge.

Instead of destroying this ridge, plant with native plants suited to the moisture conditions the ice ridge creates. Consider ways to improve access without removing the ice ridge such as a short stairway to the lake. It may be possible to grade a narrow opening to allow easy access to the lake. If this is done, consider the resulting flow of water and grade the slope away from the opening. Opening a channel in the ice ridge that flows to the lake will defeat the infiltration benefits of the ridge.

Additional Resources for More Information:

Vegetating Shorelines

Natural Shorelines Restoration Stories. Burnett County Land and Water Conservation Department. Includes before and after pictures of sites with native plantings.

Shoreland Buffer Restoration. A Guide for Landowners. Burnett County Land and Water Conservation Department. Includes step-by-step instructions for site preparation, plant selection, and planting. Also includes sources of native plants.

Shoreland Restoration: A Growing Solution Step-by-Step Guide Video with an accompanying Step-by-Step Guide brochure are available from UW-Extension Publications (# GWQ032) at \$10.00 each or for loan at the Burnett County LWCD.

Wisconsin Native Plant Sources. Seeds and plants for prairies, woodlands, wetlands, and shorelands. March 2001. Copies of this publication are available by calling 414-290-2434. To download and print, visit:

<http://clean-water.uwex.edu/pubs/index.htm>. View Home and Garden Clean Water Practices.

Plant Identification and Photos

Vascular Plants of Wisconsin is produced by the Herbarium, Department of Botany, UW-Madison. This is probably the best and most complete site for Wisconsin plants. Search by scientific name, habitat type, status, county, family, genera, or common name. The results give a detailed description of the plant and most have a photo and distribution map. Also available is a link to the *Atlas of Wisconsin Prairie and Savanna Flora* and a key to WI conifers and rare lichens of WI. <http://www.botany.wisc.edu/herbarium>

Rain Gardens

A Household Way to Improve Water Quality in Your Community.

<http://clean-water.uwex.edu/pubs/index.htm>. View Home and Garden Clean Water Practices.

Rain Gardens – A How-to Manual for Homeowners.

<http://clean-water.uwex.edu/pubs/index.htm>. View Home and Garden Clean Water Practices.

Rain Gardens: Making your Own Backyard Habitat, Chicago Wilderness

<http://www.chicagowildernessmag.com/issues/spring2001/raingardens.html>

Gardening with Water Quality in Mind, Friends of Bassett Creek

<http://www.mninter.net/~stack/bassett/raingard/raingard.pdf>

Plotting to Infiltrate? Try Rain Gardens, University of Minnesota -Extension

<http://www.extension.umn.edu/yardandgarden/YGLNews/YGLN-May0101.html#rain>

Shoreland Runoff

Rethinking Yard Care. UW-Extension Publication # GWQ009. This is an 8-page brochure that describes the impacts of nonpoint source pollution and suggests simple best management practices homeowners can use to help protect the environment. For a downloadable format, see: <http://clean-water.uwex.edu/pubs/index.htm>. View Home and Garden Clean Water Practices.

Runoff and Impervious Surfaces: a Three Part Series:

Rain and Snow – Where Do They Go and What Do They Take With Them?

This color fact sheet describes how streams and fisheries are affected by impervious (hard) surfaces and land use.

Impervious Surface – An Environmental Indicator. This fact sheet describes the results of increased impervious surfaces and community actions that can be adopted to address them.

Siting Rural Development – To Protect Lakes and Streams and Decrease Road Costs. This fact sheet explores the existing road system in Wisconsin and its cost per person and offers specific tools for minimizing pollutant sources and pollutant delivery to lakes and streams.

All three fact sheets in this series are available from the Center for Land Use Education (715-346-3783). For a downloadable version, see:

<http://www.uwsp.edu/cnr/landcenter/pubs.html>.

The following resources were used to create this publication:

Home and Garden Practices for Lake Protection. 1988. WI DNR.

Minimize Runoff from Shoreland Property. Shoreland Best Management Practices. Number 8 of 18 in the Series. 1998. University of Minnesota Extension.

Minnesota Urban Small Sites BMP Manual. Stormwater Best Management Practices for Cold Climates. 2001. Prepared for the Metropolitan Council by Barr Engineering Company.

Protecting Water Quality in Urban Areas. Best Management Practices for Dealing with Storm Water Runoff from Urban, Suburban and Developing Areas of Minnesota. 2000. Minnesota Pollution Control Agency.

Rain Gardens Nature's Way to Control Runoff Pollution. 2002. WI DNR.

The Wisconsin Stormwater Manual. WI DNR.

Wisconsin's Forestry Best Management Practices for Water Quality. 1995. Bureau of Forestry Wisconsin Department of Natural Resources.

www.stormwatercenter.net

www.shorelandmanagement.org