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NOTICE OF FINAL GUIDANCE & CERTIFICATION

Pursuant to ch. 227, Wis. Stats., the Wisconsin Department of Natural Resources has finalized and hereby certifies the following guidance document.

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DNR CERTIFICATION

I have reviewed this guidance document or proposed guidance document and I certify that it complies with sections 227.10 and 227.11 of the Wisconsin Statutes. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is not explicitly required or explicitly permitted by a statute or a rule that has been lawfully promulgated. I further certify that the guidance document or proposed guidance document contains no standard, requirement, or threshold that is more restrictive than a standard, requirement, or threshold contained in the Wisconsin Statutes.

Carmen Hardin

March 27, 2020

Signature

Date

Wisconsin Department of Natural Resources

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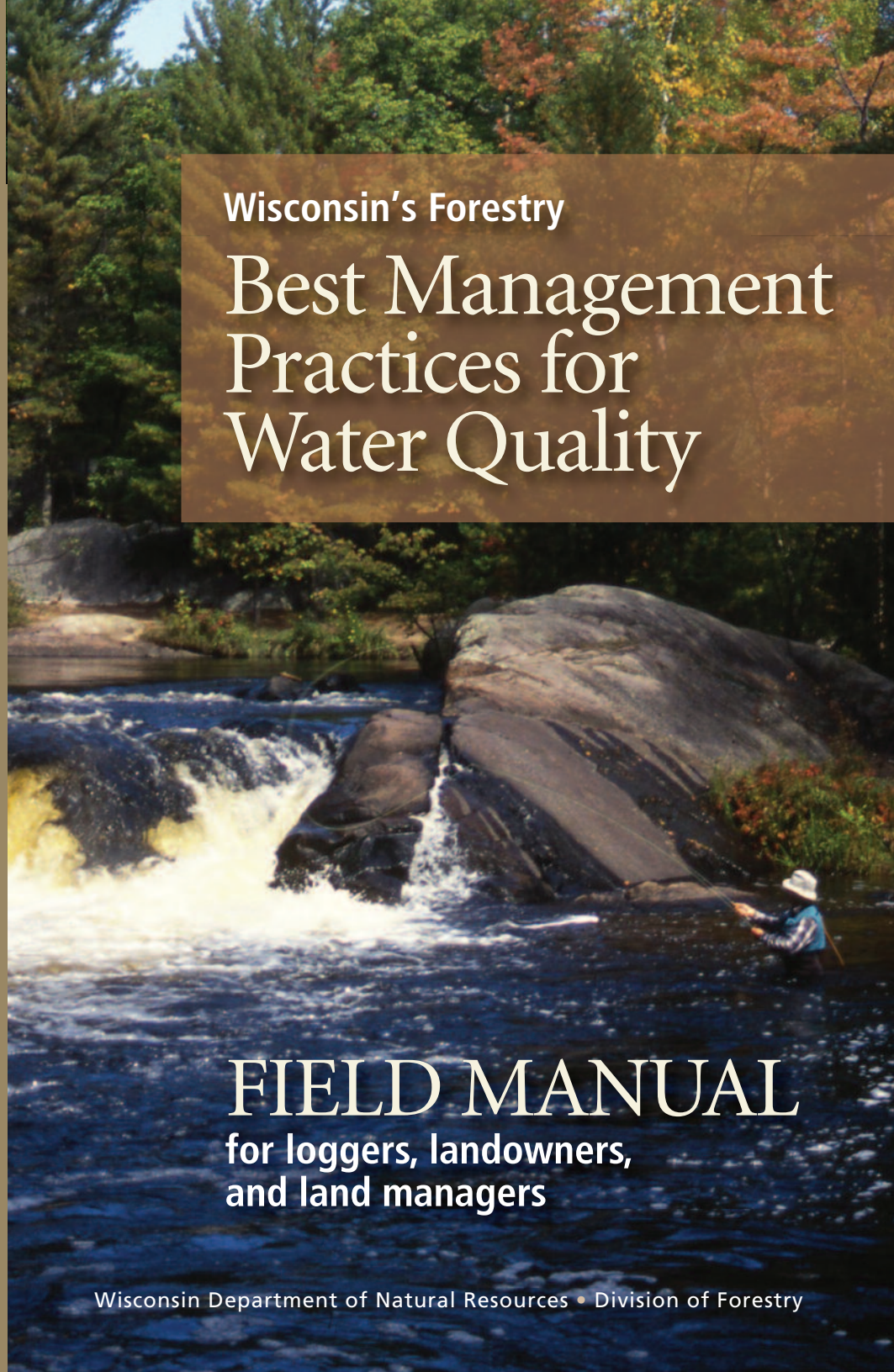

Wisconsin's Forestry

Best Management Practices for Water Quality

FIELD MANUAL

for loggers, landowners, and land managers

Wisconsin Department of Natural Resources • Division of Forestry

This document is a publication of the Wisconsin Department of Natural Resources. It fulfills a portion of the state's commitment under its Nonpoint Source Program and replaces the 2003 edition of "Wisconsin's Forestry Best Management Practices for Water Quality."

The development of this manual was directed by the Advisory Committee for Forestry BMPs for Water Quality, which has broad representation from Wisconsin's forestry community. A field manual subcommittee helped draft and review the text for this edition of the manual.

Members of the Field Manual Subcommittee were:

- Russ Aszmann, Taylor County Forestry and Recreation
- Patrick Dayton, Southwest Badger Resource Conservation & Development
- Max Erickson, Great Lakes Timber Professionals Association
- Pat Goggin, University of Wisconsin-Extension Lakes Program
- Chris Knotts, US Army Corps of Engineers
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- Tim Pulskamp, Futurewood Corp.
- Sara Sommer, USDA Forest Service
- Dale Zaug, Wisconsin Woodland Owners Association

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Wisconsin Department of Natural Resources

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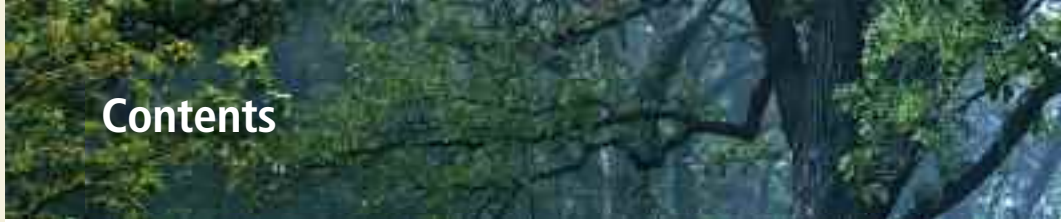

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Forests play an important role in the water cycle, contributing to the high quality of water found in Wisconsin's lakes, streams, and wetlands.

Photo by Kristin Lambert, DNR

CHAPTER 1

Introduction

Forests and Water Quality

DNR File

ABOVE: Wisconsin has over 10,000 miles of trout streams.

In Wisconsin, over 12,600 rivers and streams flow more than 84,000 miles through forests, wetlands, and grasslands. In addition to the Great Lakes of Michigan and Superior, Wisconsin has more than 15,000 inland lakes covering nearly 1 million acres. Wetlands cover an additional 5 million acres of the State, with forests covering 16 million acres.

Protecting Wisconsin's forests and water resources is crucial to the state's economy.

Wisconsin's timber industry employs over 65,000 people and contributes over $20 billion to our state's economy every year. Forests not only contribute directly to Wisconsin's economy, but also indirectly protect water quality and water-based economies. Sport fishing alone generates $2.7 billion in business and provides $200 million in tax revenue for local and state government.

Forests play an important role in the water cycle, contributing to the high quality of water found in Wisconsin's lakes, streams, and wetlands. The term "water quality" broadly encompasses the chemical, physical, and biological properties of water in lakes, streams, and wetlands. Chemical properties of water include pH, dissolved oxygen, nutrients, and the presence of chemical pollutants. Physical properties include turbidity and temperature. The characteristics and natural processes of waterbodies are also important aspects of water quality. These include stable channels, the transport of nutrients, the volume and speed of water, streambed and lakebed materials, and leaves, sticks, and logs that naturally fall into the water.

Eunice Padley, DNR

ABOVE: BMPs for skid trails help to prevent soil erosion and sedimentation.

Forestry Best Management Practices (BMPs) for Water Quality are intended to provide simple and cost-effective methods for protecting water quality in lakes, streams, and wetlands – including important ecological and waterbody characteristics – before, during, and after forest management activities. Forestry BMPs are designed to protect:

- **General water quality**, by minimizing inputs of polluted runoff,
- **Water temperature**, by ensuring an adequate and appropriate amount of shade along shorelines and streambanks,
- **Nutrient balances**, by providing necessary inputs of organic material and nutrients that serve as the basis of aquatic food chains,
- **Habitat diversity**, by making certain there is an adequate source of large woody debris for aquatic systems, and
- **Hydrologic processes**, by limiting disturbances to water flow patterns.

Maintaining water quality can be a complex process, but Forestry BMPs for Water Quality provide practical ways to achieve this goal. Most BMPs in this manual address water quality concerns by providing methods to keep sediment out of lakes, streams, and wetlands and to preserve the physical integrity and natural processes of water resources. If these issues are addressed, then most other aspects of water quality will also be protected.

If Forestry BMPs are not followed, water quality has the potential to be impacted in a number of ways, including:

- **Reduced ability for soil to absorb water.**
  This can occur when the forest floor is rutted, compacted, or otherwise damaged by equipment.
- **Increased potential for soil erosion.**
  The likelihood of soil being carried away by runoff increases when bare soil is exposed.
- **Diverted water flows.**
  Roads and skid trails can intercept water flowing over or through the soil. If the natural flow pattern is altered, wetlands or other water resources may be denied the water that they depend on.

Jay Gallagher, DNR

Carmen Wagner, DNR

ABOVE: Rutting can compact the forest floor.

LEFT: Soil that is deposited in streams can cloud the water, reducing clarity.

- **Concentrated water flows.**
  Roads, skid trails, landings, and drainage structures can collect runoff and funnel it, increasing the speed of runoff, eroding soil, and creating gullies.
- **Increased water flows.**
  Harvesting a significant percentage of the trees in a watershed can increase the amount of water running off of the land, since fewer trees are left to uptake water. Higher water flows can increase the potential for streambank erosion and may lead to flooding.
- **Reduced cover next to water resources.**
  Harvesting adjacent to streams can open the tree canopy and cause more light to reach the water surface. This may cause water temperatures to rise. Harvesting next to lakes and streams can also remove the natural source of woody debris for aquatic habitat and can eliminate the leaf litter that is an important food source for many aquatic insects.

The good news is that BMPs are used correctly over 90% of the time in Wisconsin across all landowner categories. Since 1995, nearly 600 timber sales have been monitored in Wisconsin to document how often people are using BMPs, as well as to determine how well the BMPs work. BMP monitoring has also shown that when BMPs are used, water quality is protected over 99% of the time. On the other hand, if BMPs are not used, water quality impacts have been observed nearly 70% of the time.

Paul Pingrey, DNR

ABOVE: Foresters and loggers have regularly attended BMP training sessions since 1995.

As mentioned above, regardless of landowner category – private, industrial, county, state, or federal ownership – BMPs are being used and water quality is being protected. This success is due in great part to the commitment of forestry professionals – foresters and loggers – across the state. In addition, informed landowners play a crucial role in this partnership. Nearly 60% of Wisconsin's 16 million acres of forestland are owned by private individuals and families. Responsible management of Wisconsin's forests will not only ensure a sustainable supply of wood products, but will also provide many other benefits, including clean water.

History of Wisconsin's Forestry BMPs for Water Quality

Wisconsin's Forestry BMPs for Water Quality have a simple goal—provide easy and cost-effective methods to responsibly manage forests and protect water quality.

Wisconsin's Forestry BMPs for Water Quality Program satisfies requirements of federal legislation (the 1977 Clean Water Act and the 1987 Water Quality Act) to develop and implement a program to reduce nonpoint source pollution, including nonpoint source pollution related to silvicultural activities, to the "maximum extent practicable".

Carmen Wagner, DNR

ABOVE: BMP monitoring teams meet with loggers, foresters, and landowners.

In Wisconsin, the first iteration of the Forestry BMPs was found in "Forest Practice Guidelines for Wisconsin" produced in 1990 by the Wisconsin DNR and the Wisconsin Paper Council. In May 1992, the Lakes State Forestry Alliance hosted a "Forestry Practices and Water Quality Workshop", to formalize Wisconsin's BMP Program. In 1995, "Wisconsin's Forestry Best Management Practices for Water Quality: Field Manual for Loggers, Landowners and Land Managers" was first published. The Field Manual was updated and reprinted in 1997 and 2003, but no changes were made to the actual BMPs.

Beginning in 2001, the Wisconsin DNR's Division of Forestry convened an Advisory Committee to help direct the Forestry BMPs for Water Quality Program. The Advisory Committee meets at least three times a year to review monitoring priorities, to identify training needs, and to discuss forestry and water quality issues, including the Forestry BMP Field Manual.

In January 2009, the Advisory Committee accepted a request from the Wisconsin Council on Forestry to review the BMPs in light of biomass harvesting concerns. At the same time, the Advisory Committee took the

opportunity to review several general BMP issues that had arisen since 1995. Expert review was solicited on these issues. The Advisory Committee reviewed this input and determined the initial direction for a new BMP Field Manual.

A BMP Field Manual Subcommittee, comprised of experienced BMP users, reviewed and drafted updates to the field manual text. After review and comment by the Advisory Committee, the draft field manual was presented to the public for further review. Opportunities for review and input were also provided to Wisconsin tribes throughout this process.

After reviewing public comments and suggestions, the BMP Advisory Committee made final recommendations on the Field Manual and presented it to the Chief State Forester for approval. The resulting Field Manual was also presented to the Wisconsin Council on Forestry.

1995–2008 Best Management Practices for Water Quality Monitoring Sites

ABOVE: Nearly 600 timber sales have been monitored since 1995.

Using This Field Manual

Paul Pingrey DNR

ABOVE: Landowners in Wisconsin's MFL program agree to use BMPs on their woodlands.

The Forestry BMPs for Water Quality Program is a non-regulatory program; however, the use of BMPs is mandatory in a number of situations. On public lands, such as national forests, state forests, and county forests, following BMPs are a requirement of timber sales. In addition, landowners participating in the Managed Forest Law Program agree to practice sustainable forest management on their woodlands, which includes using Forestry BMPs for Water Quality. Other programs or regulations may also require that Forestry BMPs be used.

In order to decide how and when to use specific BMPs, it is important to understand how BMPs work to protect water quality. Chapter 2 describes the different types of water resources found in Wisconsin and gives examples of how they can be affected by forestry activities.

Throughout this field manual, BMPs are identified by "💧". Each chapter provides explanations on how different activities can affect water quality and how the BMPs address those concerns. There is also additional information on methods to achieve the BMPs.

Any BMPs that are new or substantially altered from the previous field manual **are highlighted in red ink.**

In some chapters, the user will also find asides focusing on areas requiring more explanation. In addition to the BMPs, this information helps the user understand the relevant processes and concerns pertaining to a topic.

This manual is designed to assist the user in making decisions related to forest management activities and water quality. BMPs may be modified for site specific conditions with guidance from a professional forester or other natural resource professional, if the modification will provide equal or greater water protection or if the modification will have no impact on water quality. It is important to remember that water quality is more than just water clarity. Water quality includes the physical, chemical, and biological properties of lakes, streams, and wetlands.

A Closer Look at **Modifying BMPs**

BMPs are designed to protect water quality. The BMPs are generally applicable to most sites in Wisconsin, but under certain circumstances it may be appropriate to modify a BMP. When modifying a BMP, the modification should result in equal or greater water quality protection or have no impact on water quality.

When building roads, one BMP requires locating roads outside of riparian management zones (RMZs). In some instances, however, it may be preferable to build the road within the RMZ rather than outside of it. Locating a road on a flat upland area within the RMZ may be more appropriate than locating the road outside of the RMZ on a steep slope prone to erosion. By locating the road on a flat upland area at the toe of the steep slope, but closer to the stream, there will be less earth disturbed and the potential for erosion will be reduced when compared to locating the road on the steep, erosion prone slope.

BMPs can be modified on a case-by-case basis. Site specific considerations, like slope, soil, vegetation, and water resources will guide appropriate modifications.

Carmen Wagner, DNR

RESOURCES

Forestry Best Management Practices for Water Quality

- Provides information on BMPs, monitoring efforts, and training workshops.
- http://dnr.wi.gov/forestry/Usesof/bmp/

National Management Measures to Control Nonpoint Source Pollution from Forestry

- Gives guidance on scientifically sound techniques to protect lakes, streams, and wetlands from polluted runoff that can result from forestry activities.
- http://www.epa.gov/owow/nps/forestrymgmt/

Wisconsin Water Resources

CHAPTER 2

Steve Eggers, USACE

ABOVE: There are over 30 types of wetlands in Wisconsin, including hardwood swamps.

Wisconsin has more than 15,000 lakes, over 12,600 rivers and streams, and more than 5 million acres of wetlands. The water quality found in these water resources as they flow through Wisconsin's forests is a reflection of the management of our forests.

Most of the water in a forest comes from rainfall or snowmelt. This water will soak into the ground until the soil is saturated. The water will then begin to flow over the forest floor, heading downhill until there is enough concentrated flow for a stream to develop. Some of the water that soaks into the ground may be discharged into springs and seeps, returning to the surface.

All the land that drains to a given point is a watershed. Lakes, streams, and wetlands all reside within watersheds. Watersheds can range in size from just a few acres to thousands of acres. Regardless of where a property is found, it is part of a watershed.

For forestry activities, it is critical to understand where water is coming from and where water is going. The amount of timber harvested or the construction of a road can affect how water runs off a site and where that water goes. By knowing where, when, and how much water flows onto a site, you can determine the best locations for roads and skid trails, as well as what types of BMPs you will need to use to manage water flow.

In this manual, three general types of water resources are discussed – lakes, streams, and wetlands. The remainder of this chapter briefly describes each type of water resource, how to identify them, and how forestry activities can affect them.

Lakes

Ron Eckstein, DNR

A lake is a body of water with a defined bed and bank. Lakes are considered "reasonably permanent", although during extended droughts, lakes may dry up. Water level fluctuations are fairly common on lakes, with periods of high water and low water. These fluctuations can be seasonal as well as on longer term cycles. Lakes can be small ponds less than an acre in size or large bodies of water, thousands of acres in size.

ABOVE: Northern Wisconsin has a globally significant concentration of lakes.

Maintaining forested shorelines around lakes helps to protect water quality and provide important wildlife habitat. One of the ways forestry activities can affect water quality in lakes is if soil erodes from a road or skid trail and is deposited in a lake.

A Closer Look at **Beaver Ponds**

Is a beaver pond a lake? It depends. If a beaver pond appears on a topographic map or has been present for at least 20 years, the beaver pond is considered a lake because it is "reasonably permanent". In this case, the BMPs for lakes need to be followed. Twenty years is the minimum time period associated with prescriptive rights.

If it is a new beaver pond, then it would not pass the test for "reasonably permanent", and would still be considered a stream. In this case, the BMPs for streams would apply.

Dennis Pratt, DNR

Dennis Pratt, DNR

ABOVE: These new beaver ponds would not pass the "reasonably permanent" test for a lake.

Carmen Wagner, DNR

Carmen Wagner, DNR

ABOVE: This intermittent stream only has water flow in the spring and after heavy storms.

LEFT: This large perennial stream is bordered by a wide wetland with tag alders.

Streams

Streams are watercourses that have a defined channel with bed and bank. Some streams will have perennial (continuous) water flow and others will have intermittent water flow during spring snowmelt and after heavy rains. The size, flow, and character of a stream will vary depending on the soil, slope, and vegetation of the surrounding landscape.

Streams may be affected when crossed by a forest road or skid trail. If not properly designed and maintained, the crossing can provide a direct avenue for soil to enter a stream. Maintaining an adequate amount of streamside vegetation is important for shading and keeping water temperatures down, as well as for providing leaves and other organic material that are food for many aquatic insects.

Carmen Wagner, DNR

ABOVE: Marsh marigolds are a common sight in wetlands during the spring.

Wetlands

Wetlands are areas where standing water or saturated soil conditions are present long enough to support water-loving plants, like marsh marigolds, willows, tag alders, and other species. These wet conditions will also lead to development of specific soil characteristics that can help identify wetlands. Wetland soils develop after repeated cycles of saturation which last 14 days or more. These saturated conditions may only exist every other year (50% of the time). When there is standing water or the soil is saturated, anaerobic conditions are present and the soil pores are filled with water instead of air, leading to the development of unique wetland soil characteristics.

Wetlands are common along the edges of lakes and streams, but can also be found in flat areas or depressions which collect water. Wetlands are also found in unlikely places, such as on hillsides, where water may seep out of the ground.

Caution should be taken when crossing wetlands and harvesting in wetlands to ensure that both surface and sub-surface water flow patterns are maintained. Forest roads should provide adequate cross drainage and skid trails should not exhibit excessive rutting.

There are over 30 different types of wetlands covering more than 5 million acres in Wisconsin. Over 47% of the wetlands are forested and 22% are dominated by shrubs. Common forested wetlands types include ephemeral ponds, floodplain forests, northern hardwood swamps, northern wet-mesic forests, and tamarack/spruce swamps.

Carmen Wagner, DNR

ABOVE: Ephemeral pond in Forest County.

Ephemeral ponds are found in shallow depressions that hold water following snowmelt and spring rains. Ephemeral ponds typically dry out by mid-summer and are not considered lakes. The ponds are able to hold water because a thin layer of clay or other material is impeding drainage. Care should be taken not to "puncture" this layer with ruts from equipment. Wetland plants common in ephemeral ponds include black ash, smartweeds, orange jewelweed, marsh marigold, and sedges. Ephemeral ponds fill a unique habitat niche and provide critical breeding habitat for a number of wildlife species, including wood frogs and salamanders. This is in part because ephemeral ponds lack fish.

Carmen Wagner, DNR

ABOVE: Floodplain forest along the Wisconsin River in Richland County.

Floodplain forests are found along large rivers, including the Chippewa, Wisconsin, and Wolf Rivers. These forests rely on periodic flooding, especially in the spring, to deposit silt and create sites suitable for seed germination. Trees commonly found in floodplain forests include silver maple, river birch, green and black ash, and cottonwood. Historically, elms were also a significant tree in floodplain forests, but Dutch elm disease has eliminated most of these large trees. Common plant species include buttonbush, stinging nettles, ostrich fern, green-headed coneflower, and poison ivy. Oxbow lakes, sloughs, and ponds are common in floodplain forests, but should not be confused with ephemeral ponds. Because of their connection to a river during flooding events, the oxbows and sloughs often have fish in them, providing a different community structure than ephemeral ponds.

Carmen Wagner, DNR

ABOVE: Hardwood swamp in Sawyer County.

Northern hardwood swamps are deciduous forested wetlands that occur along lakes, streams, and poorly drained basins. This community occurs across the state, but is most common in the northern Wisconsin. The dominant tree species is black ash, but red maple and yellow birch may also be present. Typical plants include marsh marigold, swamp raspberry, skullcap, orange jewelweed, and many sedges. Soils may be mucks or mucky sands.

Steve Eggers, USACE

ABOVE: Cedar swamp with fern understory.

Northern wet-mesic forests, also known as cedar swamps, occur on rich peats and mucks throughout much of northern Wisconsin. Cedar swamps are relatively common in depressions that receive mineral-enriched groundwater from springs. As the name suggests, northern white cedar is the dominant tree species, but balsam fir, black ash, and spruce are also common in these forests. The understory is rich in mosses, lichens, liverworts, ferns, sedges, orchids, and wildflowers such as goldthread, fringed polygala, and naked miterwort. Cedar swamps are considered a hot spot for many species of rare plants. Older cedar swamps are usually structurally complex, as the easily wind-thrown cedars are able to root from their branch tips. The shrub layer may include speckled alder, alder-leaved buckthorn, wild currants, and mountain maple, but are susceptible to grazing by high populations of deer.

Carmen Wagner, DNR

ABOVE: Tamarack swamp in Marathon County.

Tamarack/spruce swamps are found on nutrient-poor, acidic peat soils. Tamarack and black spruce are the dominant tree species. Common understory species include alder, winterberry, Labrador tea, and sphagnum moss.

RESOURCES

Wetland Communities of Wisconsin

- Describes the 33 types of wetlands found in Wisconsin, including management opportunities, threats, additional considerations, photos, and related habitat types.
- http://dnr.wi.gov/org/land/er/communities

Wetland Plants and Plant Communities of Minnesota and Wisconsin

- Provides an easy-to-use, pictorial guide to wetlands primarily for individuals who are not botanists.
- http://www.npwrc.usgs.gov/resource/plants/mnplant/index.htm

Planning

CHAPTER 3

Carmen Wagner, DNR

Careful planning for forest management activities, such as road construction, timber harvesting, and site preparation, will minimize nonpoint source pollution. Having a management plan in place will ensure that harvest operations follow BMPs, that forest products are removed efficiently and profitably, and that sustainable forest growth and water quality protection are achieved.

LEFT: Discussions with landowners, foresters, and loggers help to ensure management objectives are met.

Forest Management Plans

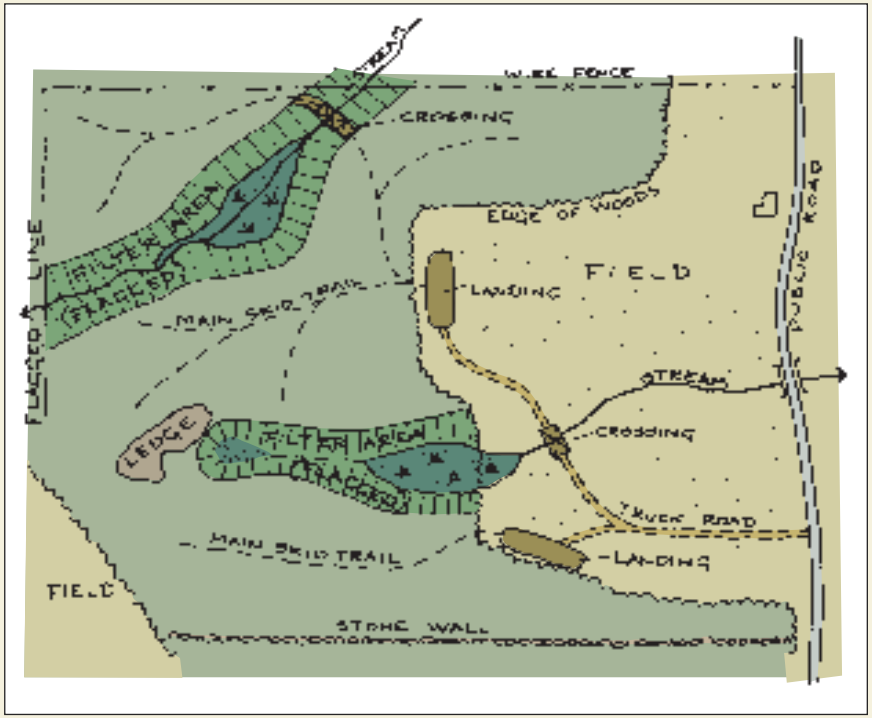
The first step is to develop a forest management plan that addresses forestry BMPs, among other important plan elements. The plan's formality and detail should be appropriate to the project size, cost, and environmental risk. The plan should include site specific forest management strategies to protect water quality. The plan should also be flexible and adaptable to changing conditions. Wisconsin DNR foresters, consulting foresters, and industrial foresters can work with you to develop a forest management plan.

The management plan should include maps that identify areas and issues discussed in the plan. These maps will be especially helpful for building forest roads and conducting timber harvests. Items that may be identified on a timber sale map include:

- Property boundaries
- Harvest unit boundaries
- Existing and proposed forest roads, skid trails, and landings
- Existing and proposed stream, dry wash, and wetland crossings

- Equipment maintenance and fueling areas
- Sensitive areas such as lakes, streams, dry washes, wetlands, floodplains, steep slopes, and erosion prone sites
- Riparian management zones and wetland filter strips
- Habitat for known threatened or endangered plant and animal species (both aquatic and terrestrial species)

EXAMPLE OF A TIMBER SALE PLAN



This map identifies sensitive areas to work around.

Mapping Resources

There are a number of resources available that can be helpful in identifying and understanding site conditions. Hard copies of these resources are available at libraries, DNR offices, and county offices. All of these resources are also available on-line, allowing users to access them from their home or office. When using any of these mapping resources, actual conditions should be confirmed by visiting the site before any work begins.

United States Geological Survey (USGS) topographic maps

The USGS topographic maps are produced at a scale of 1:24,000 and are commonly known as 7.5-minute quadrangle maps because each map covers a four-sided area of 7.5 minutes of latitude and 7.5 minutes of longitude. These maps use contour lines to portray the shape and elevation of the land. Topographic maps will portray natural features, like hills, valleys, lakes, rivers, wetlands, and vegetation, as well as manmade features such as roads, boundaries, transmission lines, and buildings.

Aerial and satellite imagery

Aerial and satellite imagery products are available at a number of different scales from a number of different resources. Black and white aerial imagery is available from as early as the 1930s, but more recent imagery is generally available in color. Depending on the time of the flight, imagery may show leaf-on or leaf-off conditions.

Natural Resources Conservation Service (NRCS) soil surveys

Soil surveys contain soil maps (at a scale of 1:24,000) as well as soil descriptions, soil properties and qualities, and reports on soil suitability and limitations. Reports include construction limitations for haul roads and log landings, suitability for roads (natural surface), and soil rutting hazard.

EXAMPLES OF MAPPING RESOURCES

USGS Topographic Map

Aerial and Satellite Imagery

NRCS Soil Survey

FEMA Floodplain Map

Wisconsin Wetland Inventory Map

Parcel Map

Federal Emergency Management Agency (FEMA) floodplain maps

Floodplains are areas adjacent to lakes, streams, and wetlands that are covered by water during a flood. Floodplain maps identify areas that will be covered by a flood that has a 1% chance of occurring in any given year, or the 100-year flood. Floodplain maps are especially important when locating stream crossings. Local floodplain ordinances will generally require a permit for any stream crossing that is located in a mapped floodplain.

Wisconsin Wetland Inventory maps

The DNR's Wisconsin Wetland Inventory maps identify wetlands across the state. The approximate boundaries of wetlands 2 acres and larger (5 acres and larger on some older maps) are shown and wetlands are classified by vegetation type, such as floating aquatic or deciduous forested. Smaller wetlands are indicated by a point symbol. Wetland boundaries should be confirmed in the field and not all wetlands are mapped.

Parcel maps

County plat books contain maps show property boundaries, as well as roads and water features. Plat books can be purchased at most county offices and at many retail stores. You can also access this information on many county web-sites that provide land record information through web-based mapping. County web-based mapping often includes parcel information, as well as many of the resources described above.

A Closer Look at the DNR's Surface Water Data Viewer

http://dnrmaps.wisconsin.gov/SurfaceWater_Viewer

The DNR's web-site provides access to a number of mapping resources. For the purposes of forest management and water quality concerns, the DNR's Surface Water Data Viewer is extremely helpful.

You can zoom in to any location in Wisconsin by using the "Zoom to…" button, and entering a city or village, township-range-section, or waterbody name. The "Zoom In" button can also be used to draw a box around an area to focus on.

After finding the area you are interested in, a number of different maps, or layers, can be displayed. The default view shows roads, lakes, and streams. By clicking on the "Layers" tab, all of the available map resources are displayed. **To view a map**, simply click on the box in front of the map that you are interested in. Some of the maps can only be displayed at a certain scale, so you may need to zoom in or out if they are not displaying.

Under **Map Layers**, you will see a number of files. Each file contains a variety of maps organized by topic. The following list provides an overview of some of the maps that may be useful when planning forest management activities.

Under the **Inland Water Resources** Folder

- **Open Water** – Areas of open water, such as lakes and large rivers, located on USGS topographic maps
- **Rivers and Streams** – Rivers and streams found on the USGS topographic maps (Note: Not all streams are mapped.)

Under the **Dam and Floodplain Program** Folder

- **FEMA Maps** – Mapped floodplains

Under the **Fisheries Management Waters** Folder

- **Trout Waters** – DNR designated trout streams

Under the **Wetlands, Plants & Habitat** Folder

- **Wisconsin Wetland Inventory** – Mapped wetlands
- **Wetland Indicators** – Soils that are typically found in wetlands (based on classification by the NRCS as somewhat poorly, poorly, or very poorly drained)

Under the **Permits & Related Data** Folder

- **Designated Water Folder** – Areas of Special Natural Resource Interest (ASNRI) referenced in Chapter 30 waterway permit standards
- **Waterway and Wetland Alterations** – Locations of Chapter 30 waterway permits, including stream crossings

Under the **Imagery & Basemaps** Folder

- **NAIP 2008 Color Air Photos** – Leaf-on color imagery from the National Agricultural Imagery Program
- **Digital Topographic Maps** – USGS topographic maps at the 1:24,000 scale

For information about something displayed on a map, click the "Identify" button and then the item on map. For instance, this will allow you to find out when a permit was issued and what the permit authorized. If a layer title is in blue text, then you can click on the title to find out more information about the map, such as map scale and map production date.

To print a map, click on the "Print" tab on the far right. A map will be created of the current view which includes a legend, scale, north arrow and other common map features. The map can be printed or saved as a .pdf.

Permits

Carmen Wagner, DNR

ABOVE: Understand all permit requirements before starting any work.

Before starting any work, be sure to obtain necessary permits and file needed notices. An overview of permits that may be required is given in Appendix A and a summary of regulations is found in Appendix B. Appendix C contains a list of local contacts for permit information.

Cost-Share Programs

Loggers and road builders, working with foresters and landowners, are usually responsible for implementing forestry BMPs. Typically, the logger bears the cost of implementing BMPs and that cost is reflected in the timber sale bid. Sometimes the landowner will implement BMPs and cover the costs themselves.

In some situations, cost-share assistance may be available for implementing conservation practices outlined in this manual. Many programs help private landowners plant trees and shrubs, but some programs also help cover the costs of management plans, forest road BMPs, and other practices, including construction of drainage structures, repair of stream crossings, and installation of seed mixes. Program requirements, funding, and availability can vary with time and location, but most programs require that an approved forest management plan be in place. Some of the most common programs are summarized below. Contact your local DNR forester, land conservation department or NRCS office (see Appendix C) for current information on these and other programs. Eligibility requirements, cost-share standards, and funding availability can change. Cost-share opportunities should be investigated before implementing any practices.

Wisconsin Forest Landowner Grant Program (WFLGP)

Jeff Martin, DNR

ABOVE: Up to 50% of the costs of tree planting can be covered by WFLGP.

The Wisconsin Forest Landowner Grant Program (WFLGP) is administered by the DNR and was created to encourage private forest landowners to manage their lands in a manner that benefits the forest resources and the people of the State. The program allows qualified landowners to be reimbursed up to 50% of the eligible cost of approved practices. Applicants must have a forest stewardship plan in place on their land or be applying to have one prepared through the WFLGP program. Cost sharing is available for plan preparation, tree planting, and soil and water conservation practices.

Wildlife Habitat Incentive Program (WHIP)

Dennis Pratt, DNR

ABOVE: WHIP provides technical and monetary assistance to improve fish and wildlife habitat.

The Wildlife Habitat Incentive Program (WHIP) is a voluntary program managed by the NRCS for landowners who want to develop and improve wildlife habitat on agricultural land and non-industrial private forest land. WHIP provides both technical assistance and up to 75% cost-share assistance to improve fish and wildlife habitat. WHIP cost-share agreements between the NRCS and the participant generally last from one year after the last conservation practice is implemented but not more than 10 years from the date the agreement is signed. Eligible practices include forest stand improvement, stream crossings, and tree and shrub planting.

Environmental Quality Incentive Program (EQIP)

Jim Halvorson, DNR

ABOVE: Improvements to forest trails can be designed and funded with EQIP.

The Environmental Quality Incentive Program (EQIP) is a voluntary program overseen by the NRCS. Through EQIP, farmers and woodland owners may receive financial and technical help with conservation practices, including forest management plans, forest trails, and stream crossings. EQIP offers contracts for up to 10 years and provides payments for implementing conservation practices. Payment rates vary with the costs of practices.

Planning Checklist

The following checklist can be used when planning forest management activities.

- ☐ Develop a forest management plan with management objectives for your property.
- ☐ Make a list of site-specific BMPs needed to protect water quality. Include in your forest management plan, timber harvest plan, and timber sale contract.
- ☐ Investigate cost-share options for implementing BMPs.
- ☐ Plan management activities to ensure that habitat of any endangered or threatened plant or animal species is protected.
- ☐ Prepare a map of your property to use during forest management activities that identifies sensitive areas and other important features.
- ☐ Reference mapping resources and confirm site conditions in the field when identifying sensitive areas.
- ☐ Obtain necessary permits and file needed notices before beginning any timber harvesting.
- ☐ Stabilize any bare soil as soon as possible to prevent erosion. Critical areas to protect include steep slopes, erosion prone sites, riparian management zones, wetland filter strips, and stream crossings.
- ☐ Have a spill containment and clean-up kit on site whenever equipment is present.

RESOURCES

Conducting a Successful Timber Sale (UWEX Publication GWQ-036)

- Reviews the steps to follow when planning and conducting a timber harvest
- http://learningstore.uwex.edu/pdf/GWQ036.pdf

DNR Financial Assistance to Landowner

- Gives an overview of forest tax laws and cost-sharing programs
- http://dnr.wi.gov/forestry/private/financial/

DNR Forestry Assistance Locator

- Provides a searchable database with contact information for DNR and cooperating foresters
- http://dnr.wi.gov/forestry/private/assist/coopforesters/

DNR Natural Heritage Inventory County Data by Township

- Offers township level list of rare species (endangered, threatened and special concern) to use for general planning purposes
- http://dnr.wi.gov/org/land/er/nhi/CountyData/

DNR Surface Water Data Viewer

- Provides access to mapping products, including USGS topographic maps, aerial imagery, DNR wetland maps, FEMA floodplain maps, and other information.
- http://dnrmaps.wisconsin.gov/SurfaceWater_Viewer

NRCS Web Soil Survey

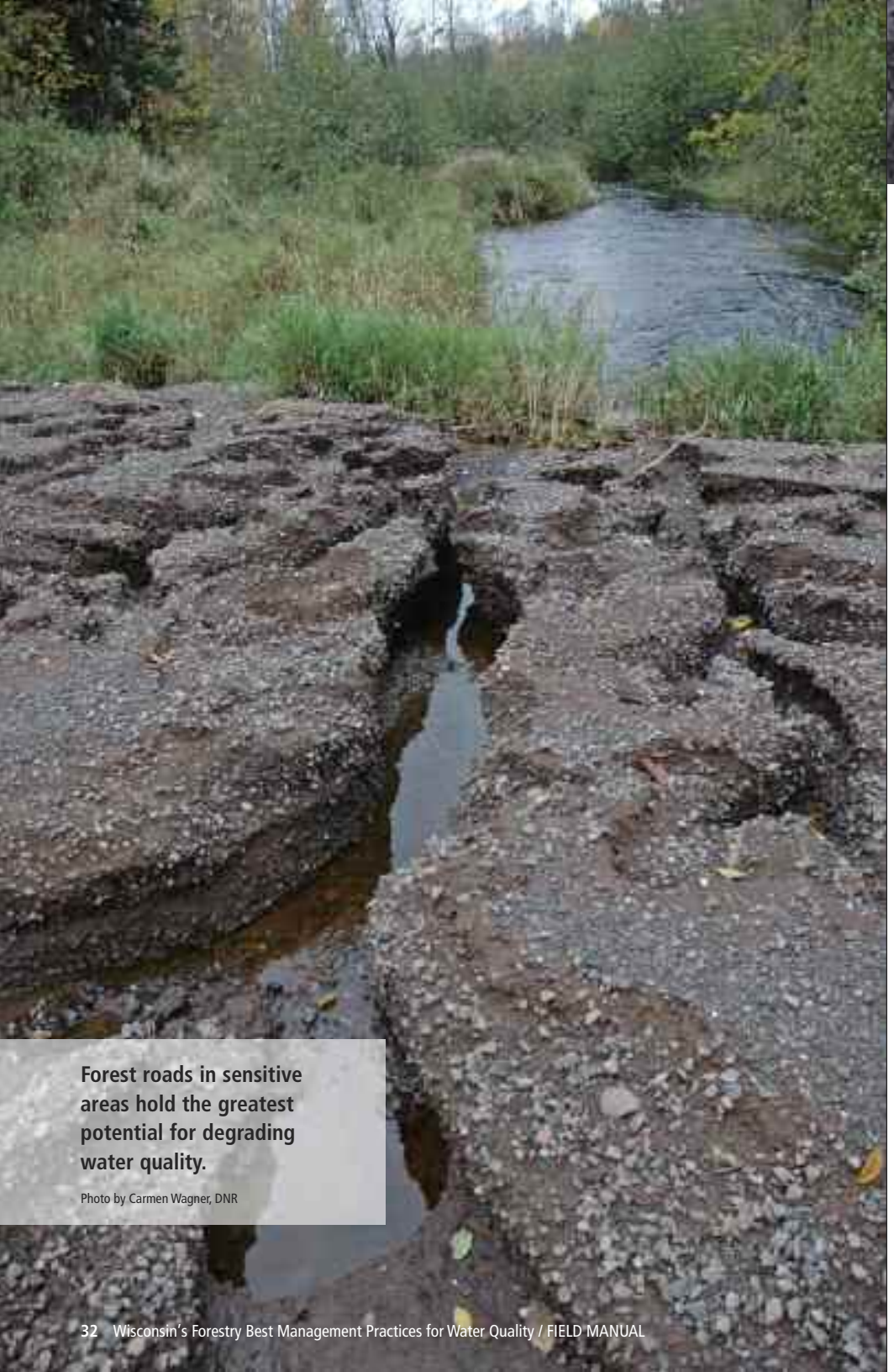
- Gives access to soil survey maps and related information
- http://websoilsurvey.nrcs.usda.gov/

Planning for Forest Stewardship: A Desk Guide (USDA Forest Service Publication #FS-733)

- Discusses the components of a forest stewardship plan
- http://www.fs.fed.us/spf/coop/library/Forest%20Stewardship%20deskguide.pdf

Wisconsin Forest Management Guidelines, Chapter 10: Forest Management Planning (DNR Pub FR-226)

- Describes the different elements of forest management plans
- http://dnr.wi.gov/forestry/publications/Guidelines



Forest roads in sensitive areas hold the greatest potential for degrading water quality.

Photo by Carmen Wagner, DNR

CHAPTER 4

Forest Roads

DNR file

ABOVE: Logging truck at a landing

Roads, skid trails, and landings form a forest transportation system. Skid trails are used to get forest products from the woods to a landing. The landing is used to stockpile timber for loading onto logging trucks. Forest roads connect the landings to a public road system. This chapter focuses on forest road considerations. Timber harvesting, skid trails, and landings are discussed in Chapter 6.

The largest contributors to nonpoint source pollution from forest management activities are forest roads that are poorly located, constructed, and maintained. Roads over steep slopes, erosion prone sites, streams, and wetlands hold the greatest potential for degrading water quality. The presence of roads can alter the flow of water over and through the ground. Heavy road use can expose soil, making it vulnerable to erosion. Stream crossings can alter the hydrology of streams. All of these factors pose risks to waterbodies; however, water quality impacts can be avoided by properly designing, constructing, and maintaining forest roads.

Well-planned and well-built forest roads have both economic and environmental benefits. Following the forest road BMPs can:

- extend the road's season of use,
- reduce road wear and maintenance costs,
- enable trucks to haul heavier loads,
- lower truck maintenance costs,
- reduce travel time, and
- protect water quality before, during, and after timber harvests.

© pedrosala, bigstockphoto.com

ABOVE: Storm water permits are needed for most land disturbing activities which expose bare soil.

Regulations

DNR storm water permits may be required when constructing, reconstructing, or maintaining roads. Storm water permits are not required for forest roads that are used solely for silvicultural purposes, if certain standards are met.

For multi-use roads, a storm water permit is needed when the construction of a new road or reconstruction of an existing road will disturb one or more acres of land or when maintenance of an existing road will disturb five or more acres. An acre of land is 43,560 square feet or an area approximately 20 feet by 2,200 feet. Contact your local DNR storm water specialist for more information (See Appendix C).

Types of Forest Roads

There are three general types of forest roads – temporary, permanent seasonal, and permanent all-season. During the planning stage, identify the type of road system that is needed to meet both forest management and landowner objectives.

Carmen Wagner, DNR

ABOVE: Temporary forest road

Temporary forest roads are the most common type of forest road. They are designed and constructed for short-term use during a specific project, like a timber harvest. These roads are used only when the ground is frozen or firm. When the project is done, the temporary road is closed, all crossing structures removed, and the road revegetated.

Carmen Wagner, DNR

ABOVE: Permanent seasonal forest road

Permanent seasonal forest roads are maintained as part of a permanent road system. They are designed to be mainly used when the ground is frozen or firm. These roads are generally narrower than permanent all-season forest roads and are built to lower engineering standards. Seasonal roads will generally have little to no surface gravel.

Carmen Wagner, DNR

ABOVE: Permanent all-season forest road

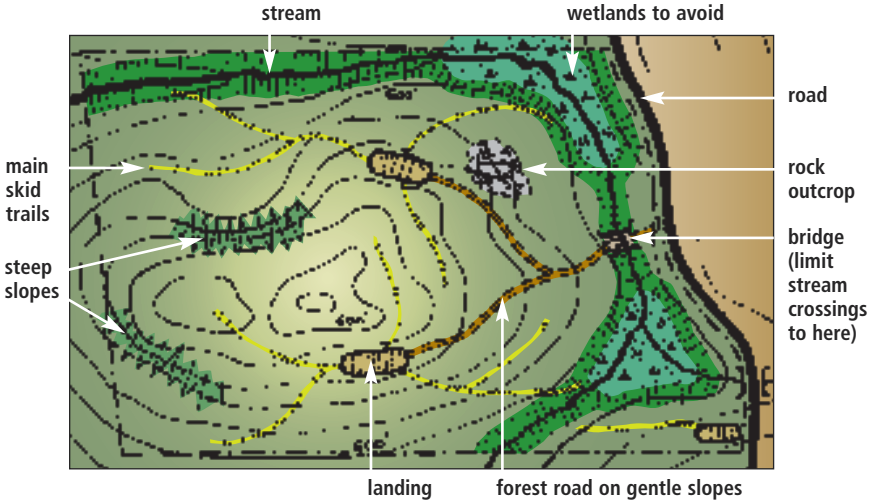
Permanent all-season forest roads are designed for year-round use, but may still have use restrictions at various times of the year, such as spring break-up. These roads are built to higher standards than the others and usually have gravel surfaces. All-season roads can be the most expensive to build and maintain.

Location and Design BMPs

Decisions made at the planning stage will affect a road's construction costs, long-term maintenance needs, service life, and the amount of nonpoint source pollution it may potentially cause. Loggers, foresters, and landowners should plan, locate, and design the road system together to ensure that it meets everyone's needs. Factors to consider when designing forest roads include:

- **The purpose and intended use of the road**, including length of use (temporary or permanent), amount and timing of use, and type of use (forest management, recreation, or other uses).
- **The physical constraints of the road**, including soils, topography, streams, dry washes, wetlands, floodplains, bedrock, and weather.
- **The environmental factors affecting the road**, including fisheries, threatened and endangered species, sensitive sites, and scenic vistas.
- **The benefits, costs, and risks associated with the road**, such as considering alternative designs and locations in order to maximize benefits while minimizing costs and risks.

Considerations in locating roads



BMPs

- **Use existing roads when they provide the best long-term access.** Consider relocating existing roads if access can be improved and environmental impacts lessened. Reconstruct existing roads to the extent necessary to provide adequate drainage and safety. Do not disturb stable road surfaces.
- **Select road locations that allow for drainage away from the road.**
- **Where possible, locate roads on well drained soils.**
- **Minimize the number of stream, dry wash, and wetland crossings.**
- **Identify optimum stream, dry wash, and wetland crossing locations before locating the rest of the road.** Roads should approach crossings at the least gradient possible.
- **Locate roads outside of riparian management zones and wetland filter strips except at crossings.** For more information see Chapter 7: Riparian Management Zone and Chapter 8: Wetlands.
- **Road grades should not exceed 10%.** If road grades greater than 10% are necessary, limit the grade length to minimize erosion or break the grade using drainage structures. Gravelling the road surface on steep grades can also help maintain stability.
  Note: Optimum road grades are less than 5%.
- **Locate roads to follow natural contours and to minimize cut and fills.** Balance cut and fills to minimize the need for bringing in fill and removing excess fill material.

A Closer Look at **Balancing Transportation Needs**

The BMPs recommend limiting the number, width, and length of both roads and skid trails. This may seem to be an impossible task because if the length of roads is limited, then the length of the skid trails is increased, and vice-versa. The goal of these seemingly contradictory BMPs is to have a balanced, well-thought out transportation system.

Carmen Wagner, DNR

When planning a forest transportation system, you will need to consider not only immediate harvest needs, but also long-term forest management and landowner objectives. Think about the harvest characteristics (volume and types of products, terrain, soils), expected uses of the transportation system, and other features of the property (shape of the property and proximity to neighboring lots).

When making decisions regarding locations of roads, skid trails, and landings, be sure to understand the trade-offs. Longer skid trails may mean increased fuel costs for the logger, but skid trails generally have shorter term impacts on water quality than roads. More roads may provide better access to a property, but are also more expensive to build than skid trails. When planning a forest transportation system, take all of these factors into consideration.

Finding the appropriate balance of roads, skid trails, and landings will vary with each site.

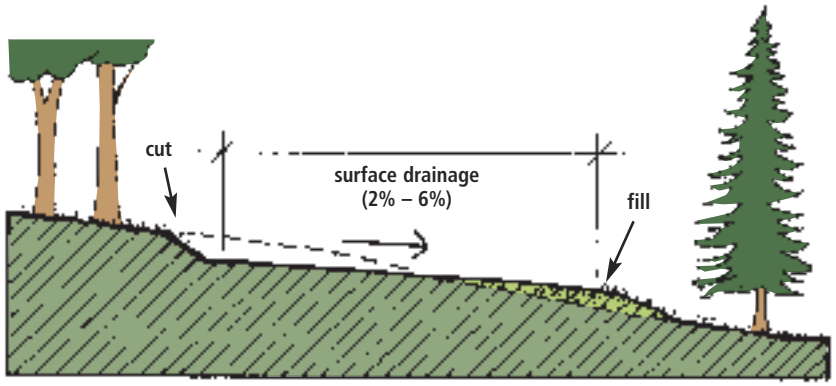
Road Construction

Two primary considerations when constructing forest roads are to get water off the road and then away from the road. The road construction BMPs focus on the first part – getting water off of the road. Water on a road can affect:

- Load bearing capacity
- Slope stability, and
- Erosion and sedimentation.

There are three common road profiles – out-sloped, in-sloped, and crowned. Ideally, the profile of any road surface should be no more than 2–6%. Profiles greater than that will make it difficult for vehicles to stay on the road in wet or icy conditions.

Out-Sloped Road



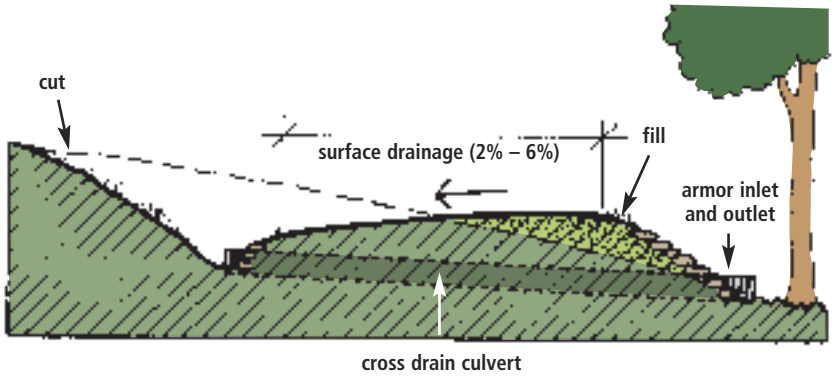
Best suited for:

- Single lane roads
- Flat or gentle road grades (8% or less)
- Seasonal and closed roads
- Roads with light traffic
- Situations where ditches or slopes will be unstable and likely to erode

Things to keep in mind about out-sloped roads:

- Surfaces should be kept smooth and rutting controlled.
- Vehicles can slide off in slippery or icy conditions.

In-Sloped Road



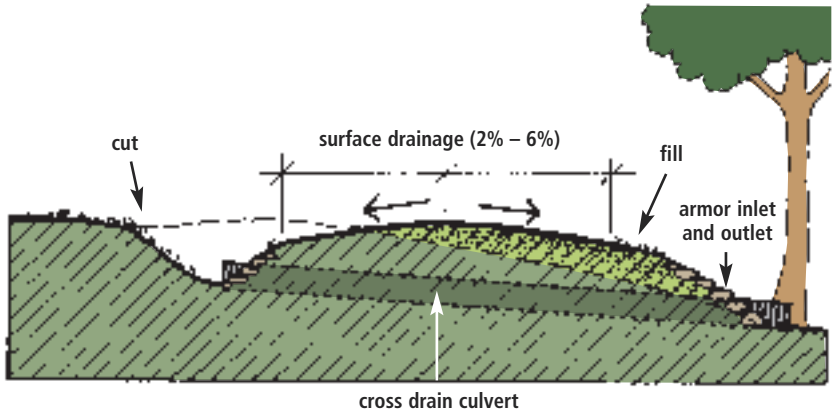
Best suited for:

- Single lane roads
- Steep road grades (greater than 8%)
- Active roads

Things to keep in mind about in-sloped roads:

- Ditches and drainage structures are needed to carry surface drainage away from the road.
- Regular maintenance of ditches and drainage structures is needed.

Crowned Road



Best suited for:

- Single and two lane roads
- Flat or gentle road grades
- Steep road grades if a single lane

Things to keep in mind about crowned roads:

- Ditches and drainage structures are needed to carry surface drainage away from the road.
- Regular maintenance of ditches, crown, and drainage structures is needed.

Road surfaces can be vegetated, native soil material, or graveled. Gravelling spreads the weight of a vehicle over a larger area, which can help prevent rutting and failure of the roadbed. A compacted layer of gravel can also seal the road surface, keeping water away from the roadbed. Roads that are expected to be used during wet conditions generally benefit from the reinforcement of the roadbed and the resistance to erosion provided by the gravel surface.

Placing gravel on a road as it approaches a stream crossing, wetland crossing, or public road can also minimize the amount of mud that is carried onto these surfaces. Driving over the gravel "shakes" the mud off.

Tim David, DNR

ABOVE: Gravelling steep slopes can help to prevent erosion

A **vegetated or native soil road surface** may be appropriate when:

- The soil is well drained or composed primarily of gravel.
- The road grade is gentle (8% or less).
- The road is not near lakes, streams, or wetlands, or there are opportunities to divert runoff and sediment prior to the water resource.
- Road use can be controlled during wet periods.
- Only limited traffic is expected on the road.
- The road will be closed.
- Gravel is scarce, must be hauled long distances, or is expensive to obtain.

Carmen Wagner, DNR

ABOVE: Native soil on a flat road grade

Carmen Wagner, DNR

ABOVE: Gravel approaches to a stream crossing

Gravelling a road may be appropriate when:

- The soil is weak, poorly drained, or prone to erosion.
- The road grade is steep and runoff is likely to run down the road, eroding the surface.
- The road is near to a lake, stream, or wetland that could receive runoff and sediment.
- The road is intended to be permanent with year-round use.
- It is not practical or possible to close the road because of recreational or other uses.
- Heavy traffic volumes are expected for the road.
- Gravel is readily available and relatively inexpensive.

Road Construction BMPs

Road surfaces are normally crowned or sloped to remove surface water. Well-designed forest roads will change road profiles as needed and will use ditches and drainage structures to control runoff, prevent erosion, and ensure water quality.

BMPs

- **Design and construct roads to remove water from road surfaces** to keep the road dry and structurally sound.
- **Construct stable cut and fill slopes that will revegetate easily** or stabilize these slopes with rock, seed and mulch, or other methods to prevent erosion if necessary.
- **Do not bury debris in the road base.** It causes uneven settling that can lead to erosion, frost-heaving, and mud holes.
- **Compact the road base material or allow it to settle before using the road to reduce the amount of water that soaks into it.** This will increase the road's carrying capacity, reduce road maintenance, and help to prevent erosion.
- **Surface the road with gravel** where steep slopes, erodible soils, or high traffic volume make the potential for surface erosion significant.
- **Locate gravel pits outside RMZs,** using proper location, development, and soil stabilization practices to minimize erosion from the pits.

Drainage Structures

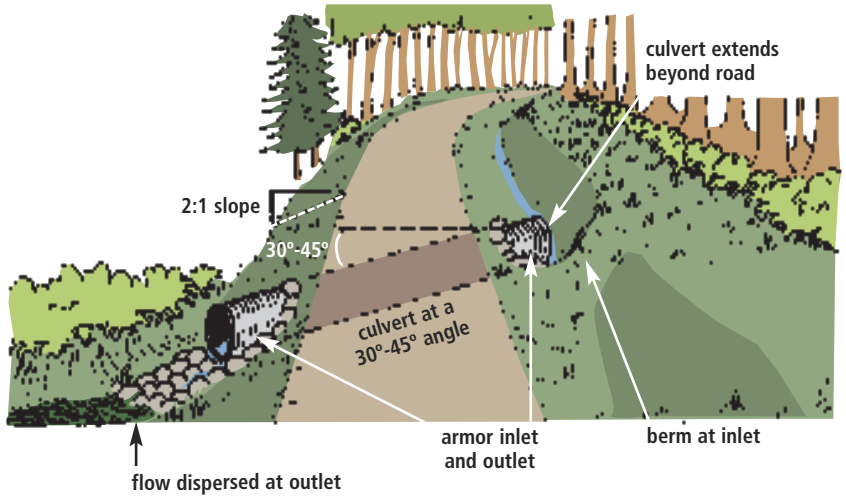
After the water is off of the road surface, you then need to get it away from the road. If water is confined to ditches along the roadside, two things will occur. First, the roadbed will become saturated and will not be able to support heavy traffic. Second, as water accumulates in the ditches and gains speed, soil can erode from the ditch, roadbed and road surface. These problems can be avoided by diverting water out of the ditches and dispersing it into the adjacent forestland. This will not only help to prevent erosion, but will also ensure that a high quality road system is in place. Placement of drainage structures is often dictated by the landscape; however, care should be taken to avoid directing runoff directly into lakes, streams, dry washes, and wetlands.

Road drainage structures include cross drains and diversion ditches. Cross drains are designed to move water from a roadside ditch on one side of the road to the other and include cross drain culverts, open-top culverts, rubber belt diverters, broad-based dips, and water bars. Diversion ditches direct water away from the road and disperse the water across the forest floor.

Jeff Martin, DNR

ABOVE: Broad-based dips allow traffic while diverting runoff into the forest

Cross Drain Culverts



Best suited for:

- Permanent roads

Things to keep in mind about cross drain culverts:

- The road stays dry because water is diverted under the road.
- Cross drain culverts can be expensive to install, but allow faster traffic speeds.
- They can become plugged by sediment and other debris, requiring frequent maintenance inspections.
- They can be used on temporary roads, but should be removed when the road is closed.

Open-Top Culverts

Craig Hollingsworth, DNR

Best suited for:

- Permanent roads with low traffic volumes and temporary roads

Things to keep in mind about open-top culverts:

- The road stays dry because water is diverted under the road.
- Open-top culverts are easy and inexpensive to install, but require slow traffic speeds.
- They can be used on road with grades greater than 10%.
- They can easily become plugged by sediment and other debris, requiring frequent maintenance inspections.
- Open-top culverts can be damaged by high volumes of traffic and heavy equipment.
- On temporary roads, they should be removed when the road is closed.

Rubber Belt Diverters

Craig Hollingsworth, DNR

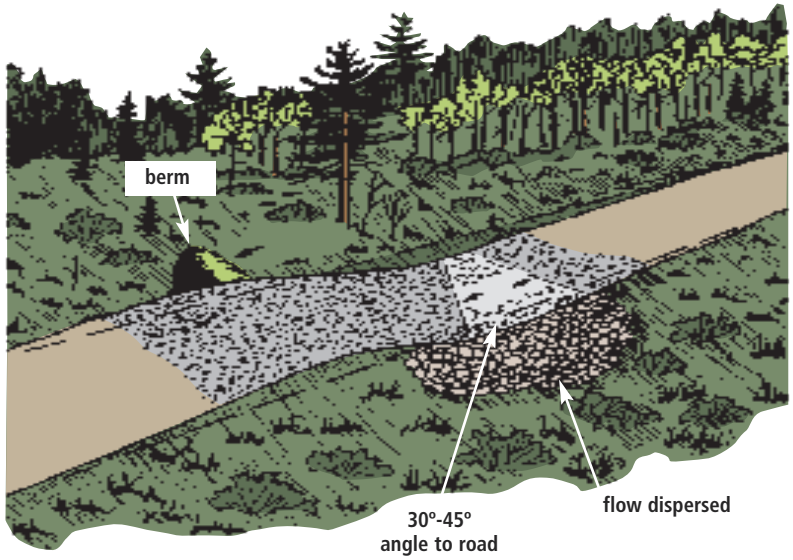
Best suited for:

- Permanent roads with low traffic volumes and temporary roads

Things to keep in mind about rubber belt diverters:

- They are easy and inexpensive to install, but require slow traffic speeds.
- They can be used on steep roads without ditches.
- Rubber belt diverters can accumulate dirt, leaves, and other debris which will require cleaning.
- Rubber belt diverters can be damaged by high volumes of traffic and heavy equipment.
- Rubber belt diverters can be torn apart if logs are skidded over them.
- On temporary roads, they should be removed when the road is closed.

Broad-Based Dips (Grade Dips)



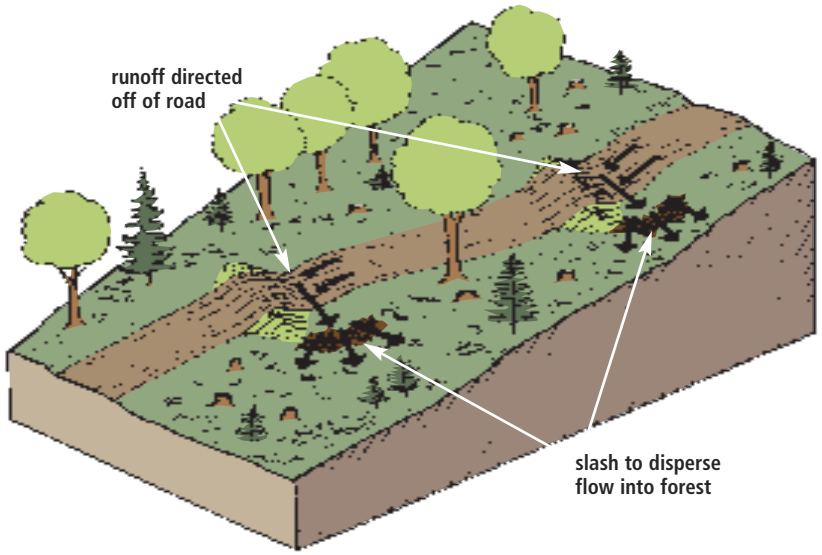
Best suited for:

- Permanent roads, temporary roads, and skid trails

Things to keep in mind about broad-based dips (grade dips):

- They can be used on active roads with or without ditches.
- They are most effective on roads grades less than 10%.
- Broad-based dips are difficult to construct on steeper roads.
- On high traffic volume roads, gravel may be required to prevent rutting. On low traffic volume roads, a vegetated surface should suffice. Limiting traffic during wet periods will also help prevent deterioration of the road and dip.
- Care is needed to ensure that the dip is not lost due to high traffic volumes and road grading.
- For high speeds and low clearance vehicles, the approaches should be longer and flatter. For low speeds and high clearance vehicles, the approaches can be shorter and deeper.

Water Bars



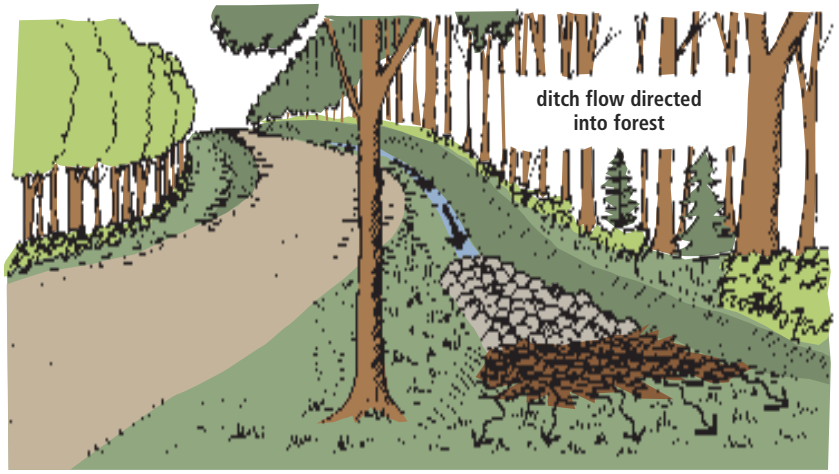
Best suited for:

- Closed roads and skid trails

Things to keep in mind about water bars:

- They are easy and inexpensive to install.
- They can be constructed with soil, logs, or slash.
- They are not intended to be driven over.
- They require minimal maintenance.

Diversion Ditches



Best suited for:

- Permanent roads, temporary roads, and skid trails

Things to keep in mind about diversion ditches:

- They can be used on roads with or without ditches.
- They are easy and inexpensive to install.
- Take advantage of the natural dips in the topography to direct water away from roads and skid trails. Avoid directing runoff directly into lakes, streams, dry washes, and wetlands.
- Be sure that the diversion ditch goes downhill. If it goes uphill, it will drain water onto the road.
- Rocks or slash can be used at the end of the diversion ditch to slow water flow.
- Maintenance may be needed if sediment is filling the diversion ditch.

Table 4-1. **Recommended Uses for Different Drainage Structures**

	ROAD TYPE				TRAFFIC VOLUMES			SLOPES	
STRUCTURE	Permanent All-Season Roads	Permanent Seasonal Roads	Temporary Roads	Skid Trails	High Traffic Volume	Low Traffic Volume	No Vehicular Traffic	Rolling to Steep Slopes	Flat to Gentle Slopes
Cross drain culvert	●	●	●		●	●		●	●
Open-top culvert	●	●	●			●	●	●	●
Rubber belt diverter	●	●	●			●	●	●	●
Broad-based dip	●	●	●	●	●	●	●		●
Water bar			●	●			●	●	●
Diversion ditch	●	●	●	●	●	●	●	●	●

Craig Hollingsworth, DNR

ABOVE: Construct broad-based dips shallow enough to accomodate expected vehicles.

Drainage Structure BMPs

BMPs

- **Install drainage structures to remove water from the road surface and ditches.** Drainage structures should be installed immediately above steep grades, below bank seepages, and where water will run onto landings or forest roads. Space these structures at intervals close enough to minimize runoff volume and speed, avoiding ditch erosion. As road grades increase, use more drainage structures. (See Table 4-2)

Table 4-2. **Recommended Maximum Distances Between Drainage Structures on Forest Roads and Skid Trails**

	Maximum distance between water bars (feet)		**Maximum distance between all other drainage structures** (feet)	
Road Grade (%)	**High Erosion Risk** (most sandy soils and silt soils)	**Low Erosion Risk** (most rocky soils and clay soils)	**High Erosion Risk** (most sandy soils and silt soils)	**Low Erosion Risk** (most rocky soils and clay soils)
0–3	175	250	250	350
4–6	125	200	175	250
7–9	100	175	125	175
10–12	75	150	75	125
13–15	60	100	60	100
16–20	50	75	50	75
21–30	40	65	40	65
30+	30	50	30	50

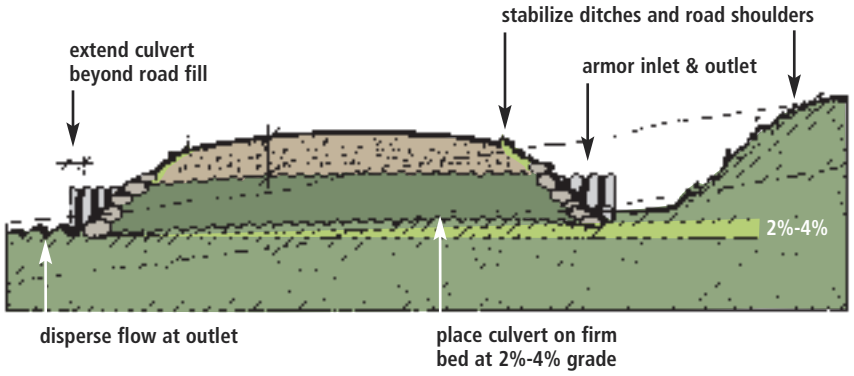
Note: Broad-based dips generally become ineffective on slopes greater than 10%.

- **Install a berm at the inlets of drainage structures, if needed, to direct water into the structures.** Use rock riprap, mulch, and/or seeding at the inlets to prevent water from eroding and undercutting the structures.
- **Provide erosion protection at the outlets of drainage structures to minimize erosion and disperse the water, allowing it to soak into the ground.** Options include rock riprap, slash, mulch, and/or seeding.

Drainage Structure BMPs (continued)

BMPs

- **Install drainage structures at grades of at least 2% more than the ditch grade and at a 30 to 45 degree angle to the road.**
- **Check drainage structures** to ensure that they are not filling with sediment or other debris. Clean if needed.
- **Install cross drain culverts long enough to extend beyond the road fill. Size culvert cross drains according to the size of the road and the area drained by the ditch.** To avoid clogging, culverts should be a minimum of 12 inches in diameter.
- **Install cross drain culverts on a surface of compacted granular material.** Firmly compact fill material around the culvert, particularly the bottom half. To prevent crushing, cover the top of the culvert with fill to a depth of 1/3 of the pipe diameter, or at least 12 inches (whichever is greater).
- **Construct broad-based dips deep enough to provide adequate cross drainage and wide enough to allow trucks and equipment to pass safely.** On high traffic volume roads, place a surface of crushed rock stone or gravel in the dip and on the mound to prevent rutting from occurring. On low traffic volume roads and where traffic can be limited during wet periods, a vegetated surface may suffice.



A Closer Look at Road Building Challenges in the Driftless Area

In southwest Wisconsin is the Driftless Area, which is characterized by ridges with steep sides leading down to valley floors. Silty soils with a silt loam surface are common in this area. The steep slopes combined with these erosive soils create some unique challenges when building roads, but with thoughtful planning, road construction, installation of drainage structures, and timely maintenance, these challenges can be overcome.

Drainage structures and cut and fill slopes can be difficult to stabilize and maintain in this landscape. Gravelling the road surface is an option, but dump trucks may not be able to climb the steep inclines. Another option is to seed the road surface with grass, but traffic must be kept to minimum during wet periods to maintain the road profile and to protect drainage structures. In addition, out-sloped road profiles may need to exceed the recommended 2–6% to ensure adequate drainage if the road surface is well vegetated. If the road profile exceeds 6%, traffic should be kept off the road in slippery and icy conditions in order to prevent slide-offs.

Roads can be constructed entirely by cutting, rather than balancing cut and fills. Broad-based dips and other drainage structures can be shaped by cutting away soil and depositing excess soil elsewhere, rather than using it as part of the road. This will help prevent erosion of newly placed fill on steep slopes and provide a more stable roadbed.

The steep slopes also lead landowners to use less common drainage structures, such as open-top culverts and rubber belt diverters. Broad-based dips often do not work in this area because of the length of run needed when constructing the approach to a dip.

In this area of the state and others, modifications may be required to ensure that water quality is protected as intended by the BMPs. As described in Chapter 1, modifications for specific site conditions should be made with guidance from a professional forester or other natural resource professional. As with any project, be sure to consider alternatives, especially when dry washes, springs, seeps, and other sensitive water resources are present.

Patrick Dayton, Southwest Badger RC&D

ABOVE: Steep slopes in the Driftless Area can present significant road building challenges

Soil Stabilization BMPs

Soil stabilization practices are used when soil is exposed and natural revegetation is inadequate to prevent soil erosion (the detachment of soil) and to control sedimentation (the movement of soil). Soil can be exposed during road construction, by heavy volumes of traffic, and when grading roads and skid trails. Some practices are designed to hold the soil in place and to prevent it from eroding, such as seeding and mulching. Other practices are intended to slow and capture sediment once it has begun to erode, such as straw bales and silt fences. There are a multitude of practices available to select from, depending on grade, slope length, and location. These practices are often used in conjunction with one another to ensure water quality protection.

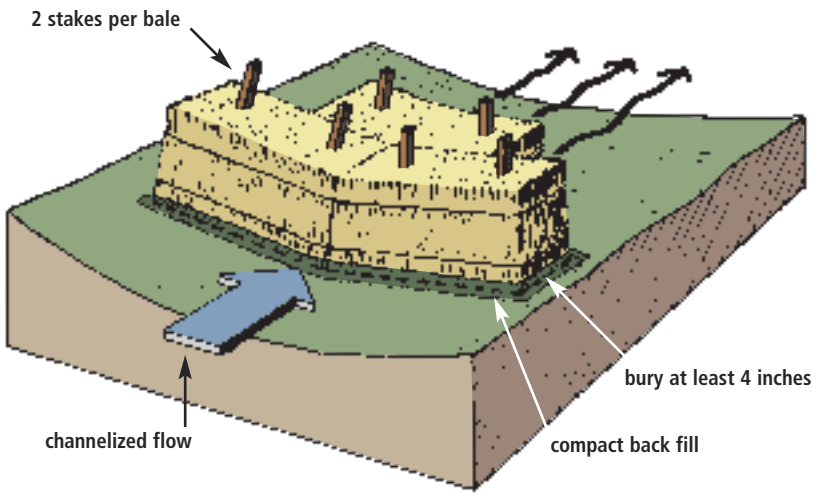
BMPs

- **Use seed, mulch, and/or erosion control netting where necessary to minimize soil erosion into lakes, streams, and wetlands.** See Tables 4-3 and 4-4.
- **Install sediment control structures where necessary to slow the flow of runoff and to trap sediment until vegetation is established at the sediment source.** See Tables 4-3 and 4-4.
- **Maintain, clean, and replace sediment control structures, as needed, until areas of exposed soil are stabilized.**

Timing is critical when implementing soil stabilization practices. Steps should be taken to stabilize any bare soil as soon as possible after it is disturbed. In the fall, seed may not germinate until the following spring. Soil stabilization practices in addition to seed and mulch may be needed then to hold the soil in place during fall rains and spring snowmelt until the vegetation becomes established. Temporary soil stabilization may still be needed for winter harvests. Install temporary practices to prevent erosion and then install permanent practices after the site has become dry enough for equipment.

After the site has become stabilized by vegetation, temporary stabilization practices, like silt fences, can be removed. It may be necessary to seed and mulch in areas that are disturbed by the removal of the temporary structures. Additional information on seed mixes can be found in Appendix D and on erosion and sediment control products in Appendix E.

Straw Bales for Temporary Ditch Checks



Silt Fence for Temporary Sediment Control on Slopes

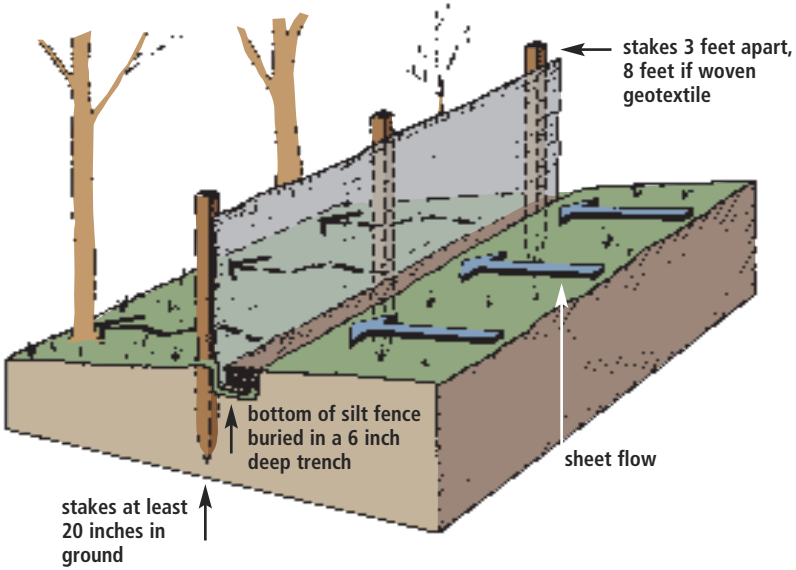


Table 4-3. Recommended Erosion and Sediment Control Options for Ditches (channelized flow)

	DITCH GRADE									
	<2%			2%–4%			4%–6%			
	Max. length (ft.)			Max. length (ft.)			Max. length (ft.)			
	300	600	1,200	300	600	1,200	300	600	1,200	Comments
EROSION CONTROL OPTIONS										
Seed with mulch										
Seed with light duty erosion mat										
Seed with medium duty erosion mat	$	$	$							
SEDIMENT CONTROL OPTIONS										
Temporary ditch checks, such as straw bales, fiber logs, and triangular silt dikes										Install one ditch check for every 2 ft. of drop, max. 200 ft. spacing. Not recommended for slopes less than 1%
Stone ditch checks	$	$	$							Install one ditch check for every 2 ft. of drop. Use No. 2 coarse aggregate, railroad ballast, or breaker run.

Notes:

1. $ = Practice is effective, but may not be cost efficient.
2. Erosion control mats should extend a minimum of 1 foot upslope vertically from the ditch bottom.
3. If erosion control nets are not properly anchored, animals can become entangled in them. Use appropriate materials in areas where there is a high probability of animals becoming entangled, such as along lakes, streams, and wetlands.
4. Effective erosion and sediment control involves minimizing the amount of time that soil is exposed, selecting a combination of practices, and not relying on just one practice. Grade length can be shortened by installing drainage structures such as diversion ditches.
5. See Appendix D: Seed Mix Information, Appendix E: Erosion and Sediment Control Products, and the WisDOT's Erosion Control Product Acceptability Lists for Multi-Modal Applications for more information on products and manufacturers.

Table 4-4. Recommended Erosion and Sediment Control Options for Slopes (sheet flow)

	SLOPE												
	6:1 or flatter			4:1			3:1			2:1			
	Slope length (ft.)			Slope length (ft.)			Slope length (ft.)			Slope length (ft.)			
	0-30	30-60	60-120	0-30	30-60	60-120	0-30	30-60	60-120	0-30	30-60	60-120	Comments
EROSION CONTROL OPTIONS													
Seed with mulch													
Seed with light duty erosion mat	$	$	$	$	$	$							
Seed with medium duty erosion mat	$	$	$	$	$	$							
Riprap	$	$	$	$	$	$	$	$	$				Angle of repose must be considered.
SEDIMENT CONTROL OPTIONS													
Temporary sediment control practices, such as silt fences, straw bales, and fiber logs.	Use at toe of slopes to intercept and detain small amounts of sediment.												

Notes:

1. $ = Practice is effective, but may not be cost efficient.
2. On steeper slopes that require a heavier duty mat, use the appropriate lighter duty mat or seed and mulch for the first 30 feet to 60 feet of the slope.
3. If erosion control nets are not properly anchored, animals can become entangled in them. Use appropriate materials in areas where there is a high probability of animals becoming entangled, such as along lakes, streams, and wetlands.
4. Effective erosion and sediment control involves minimizing the amount of time that soil is exposed, selecting a combination of practices, and not relying on just one practice. Grade length can be shortened by installing drainage structures such as diversion ditches.
5. See Appendix D: Seed Mix Information, Appendix E: Erosion and Sediment Control Products, and the WisDOT's Erosion Control Product Acceptability Lists for Multi-Modal Applications for more information on products and manufacturers.

A Closer Look at **Why Roads Fail**

There are three components to a successful forest road – **location, construction,** and **maintenance.** When forest roads fail, there are numerous results, including:

Carmen Wagner, DNR

- Access is lost or a longer access route may be required.
- Costs are incurred repairing the road or using less direct access points.
- Income may be lost or delayed until forest products can be safely transported.
- Water quality, wildlife habitat, and other resources may be impacted.

Common causes of road failures include:

- **When siting roads, factors such as soils, slopes, and nearby land management are not fully evaluated.** Examples include:
  - — Weak soils that cannot support traffic.
  - — Steep grades and "climbing turns" that are difficult for logging equipment and trucks to use safely.
  - — Poorly sited entrances that receive runoff from adjacent farm fields or roads.
- **When designing and constructing roads, standards are not followed.** Examples include:
  - — Not using enough (or any) drainages structures.
  - — Undersizing stream and dry wash crossings.
  - — Incorrectly installing drainage and crossing structures.
- **When maintaining and closing roads, steps are not taken to protect the road.** Examples include:
  - — Not repairing the road surface and profile after a heavy use or prior to closing.
  - — Using road in poor conditions (too wet or too soft) that cannot support the traffic.
  - — Not gravelling or vegetating the road to maintain a stable surface.

Road Maintenance BMPs

Roads must be well maintained. If not, erosion control and drainage structures may quickly degrade and endanger water quality. For both active and inactive roads, follow the BMPs in the previous Soil Stabilization section.

Active Roads

Active roads are generally open to vehicular traffic. Depending on the landowner and type of road, this may include logging trucks, light trucks, automobiles, tractors, utility terrain vehicles (UTVs), or ATVs. A road may be closed seasonally or may be closed to other users, but still considered an "active" road.

- **Inspect the road system at regular intervals,** especially after heavy rainfall, to detect problems and to schedule repairs.
- **Clear debris from culverts, ditches, dips, and other drainage structures to prevent clogging that can lead to washouts.** Place the debris where it cannot be washed back into these structures or washed into open water.
- **Keep traffic to a minimum during wet periods and spring breakup to reduce maintenance needs.**
- **Shape road surfaces periodically to maintain proper surface drainage.** Fill in ruts and holes with gravel or compacted fill as soon as possible to reduce erosion potential.
- **Remove berms along the edge of the road if they will trap water on the road.**
- **When dust control agents are used, apply them in a manner that will keep these compounds from entering lakes, streams, wetlands, and groundwater.** Consult a qualified road engineer from the County Highway Commissioner's office or Wisconsin Department of Transportation for assistance in selecting the appropriate chemicals and amounts. Note: It is illegal to spread oil on roads, land, and water in Wisconsin.

BMPs

BMPs

Inactive Roads

Inactive roads are generally not used by vehicles. When forest roads are inactive for extended periods, closing the road system will help to protect the road surface and drainage structures. Consider erecting a barrier to traffic, such as a gate or berm, and post "closed" signs at the entrance of the road. If temporarily closed, state the length of time and/or reason for the closure. Inviting acceptable uses may be helpful to assure compliance.

- **Remove all temporary drainage and crossing structures.**
- **Shape all road system surfaces to maintain proper surface drainage, if necessary.**
- **Install water bars where necessary.** See the Water Bars section and follow recommendations in Table 4-2.
- **Inspect and maintain road surfaces, drainage structures, and crossings to minimize erosion.**

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ABOVE: Gates can close roads to unauthorized use, but still allow easy access

Carmen Wagner, DNR

ABOVE: Berms are effective when frequent access is not required

RESOURCES

DNR Storm Water Management Technical Standards

- Contains the requirements for planning, designing, installing and maintaining a wide variety of erosion and sediment control practices, including channel erosion mats, ditch checks, and silt fences
- http://dnr.wi.gov/runoff/stormwater/techstds.htm

Erosion Control Product Acceptability List for Multi-Modal Applications (Wisconsin DOT)

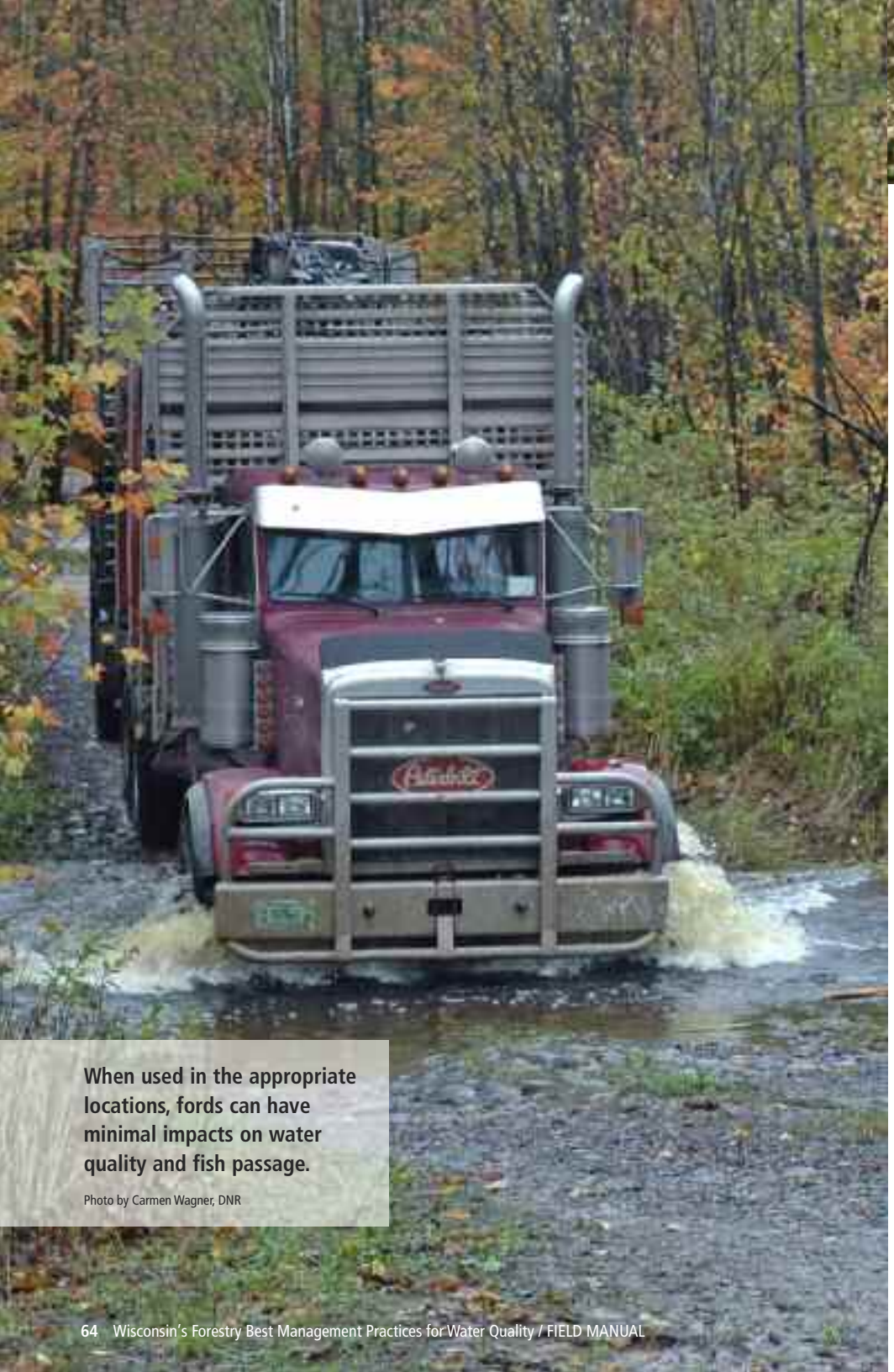
- Lists erosion control products that meet the WisDOT's specifications for road construction and the manufacturers of the products
- http://www.dot.wisconsin.gov/business/engrserv/pal.htm

Forest Management Practices: Managing Water Series (University of Minnesota Extension Service Publications #1-13)

- Provides guidance on planning, constructing and maintaining forest roads and skid trails to limit erosion, help meet landowner objectives, improve safety, and reduce costs.
- http://dnr.wi.gov/forestry/Usesof/bmp/bmpownerguides.htm#3

A Landowner's Guide to Building Forest Access Roads (USDA Forest Service Publication #NA-TP-06-98)

- Provides recommendations for basic planning, construction, drainage, maintenance, and closure of low-speed forest roads
- http://na.fs.fed.us/spfo/pubs/stewardship/accessroads/accessroads.htm



When used in the appropriate locations, fords can have minimal impacts on water quality and fish passage.

Photo by Carmen Wagner, DNR

CHAPTER 5

Stream Crossings

Carmen Wagner, DNR

ABOVE: This culvert is undersized and perched, creating a barrier to fish movement.

Stream crossings, especially culverts, can significantly affect streams if BMPs are not used to minimize impacts with proper design, installation, and maintenance. Poorly designed, installed, or maintained crossings can change the physical characteristics of a stream – its speed, depth, and channel shape. Crossings can also create passage problems for fish and other species. These problems can include:

- Insufficient water depths in a crossing
- Excessive velocity (exceeding fish swimming capacities) in a crossing
- Absence of stream substrate in the crossing
- Debris blocking the inlet, impeding water flow, sediment transport, and fish passage through the crossing
- Scour at the crossing outlet, creating physical barrier to aquatic passage upstream
- An overhanging or perched outlet of a crossing, impeding upstream fish passage.

Planning

When planning a stream crossing, first determine whether there are any other ways to access the parcel that would not require a new crossing. If the crossing is required, you will need to consider:

- the stream channel
- the stream banks
- the approaches to the crossing.

The ideal location for a stream crossing is where the stream is straight and narrow with low banks and firm rocky soil. The road should approach the stream at the least gradient possible.

Factors in properly sizing a crossing include storm frequency, drainage area, and flow rates. Permit standards for crossings include information on how to size crossings. A properly sized structure will reduce fish passage problems and reduce the likelihood of high water levels undermining or washing out the crossing. Washouts can be avoided by providing a high water release as part of the approach. This high water release can be a dry culvert or dip in the approach.

Depending on the intensity of use, a temporary or permanent stream crossing may be more appropriate. Common temporary stream crossing designs used in forest management include portable bridges, timber mats, and pole fords. For permanent crossings, bridges, culverts, and fords are often used.

Regulations

A permit from the DNR is required to construct or install a stream crossing on any navigable stream. A stream is navigable if it has a defined bed and banks and if it is possible to float a canoe or other small craft in the waterway on a regular reoccurring basis – even if only during spring snowmelt. Streams identified on USGS topographic maps (7.5 minute/1:24,000 scale) are considered navigable. It is important to note that there are navigable streams that do not appear on these maps. If you have a question about navigability, contact your local DNR water management specialist (see Appendix C).

Permits may also be required from local zoning offices. If FEMA has mapped a floodplain on the stream, local floodplain regulations will apply.

Shelly Wrzochalski, DNR

LEFT: Installing temporary stream crossings like this portable bridge, requires a permit from the DNR.

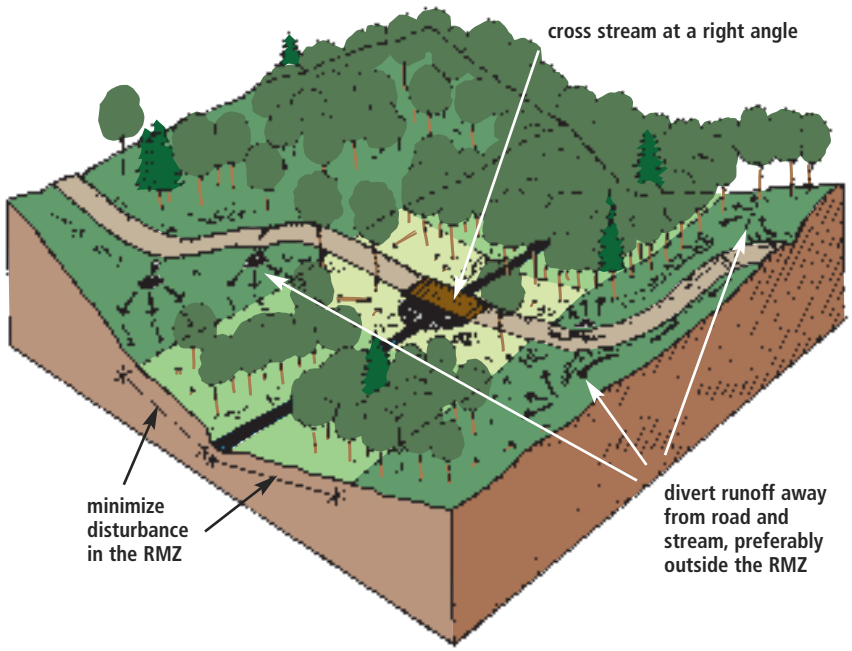
General Stream Crossing BMPs

The BMPs provide general guidance on the design, installation, and maintenance of stream crossings. Permit requirements include detailed information on sizing and installing stream crossings. Be sure to refer to and understand permit requirements.

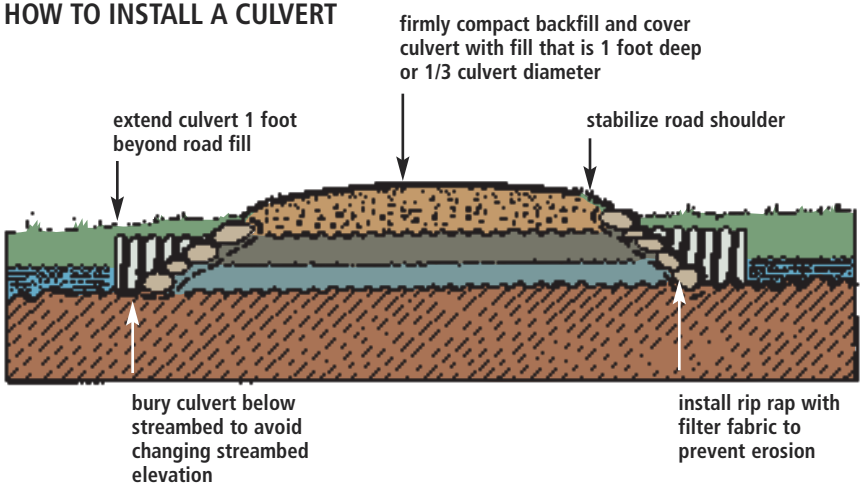
BMPs

- **Identify optimum stream crossing locations.** Optimum locations are where the stream channel is straight and narrow with low banks and firm rocky soil. Roads should approach streams at the least gradient possible.
- **Install stream crossing structures at right angles to the stream, where practicable.**
- **Use soil stabilization practices on exposed soil at stream crossings.** Use seed and mulch and install temporary sediment control structures to minimize erosion into streams. Maintain these practices until the soil is stabilized. Refer to the Soil Stabilization section in Chapter 4.
- **Design, construct, and maintain stream crossings to avoid disrupting the migration or movement of fish and other aquatic life.** Consider clear-span bridges, bottomless arch culverts, and temporary stream crossings that retain the natural stream bottom.
- **Install stream crossings using materials that are clean, non-erodible, and non-toxic to aquatic life.**
- **Minimize channel changes and the amount of excavation or fill needed at crossings.**
- **Limit construction activity in the streambed to periods of low flow or no flow.** Keep use of equipment in the stream to a minimum.
- **Use diversion ditches, broad-based dips, or other practices on the road approaches to prevent road runoff from entering the stream.** Direct the runoff into undisturbed vegetation, preferably outside the riparian management zone (RMZ).
- **Stabilize approaches to crossings with aggregate or other suitable material to reduce sediment entering the stream.**

CONSIDERATIONS WHEN INSTALLING A STREAM CROSSING



HOW TO INSTALL A CULVERT



Stream Crossing BMPs for Culverts

The following BMPs address culverts that are used for stream crossings. When using culverts for road drainage, refer to the Drainage Structure section of Chapter 4: Forest Roads. When using culverts for cross drainage in wetlands, refer to the Wetland Road, Skid Trail and Landing BMPs section of Chapter 8: Wetlands.

BMPs

- **Install culverts that extend at least 1 foot beyond the road fill.**
- **Install culverts that are large enough to pass flood flows.** To avoid plugging, wash-outs, and upstream flooding, culverts should be a minimum of 18 inches in diameter.
- **Install culverts so there is no change in the streambed elevation.** Culverts should not dam or pool water.
- **Firmly compact material around culverts, particularly the bottom half.** To prevent crushing, cover the top of culverts with fill to a depth of one-third of the culvert diameter or at least 12 inches, whichever is greater.
- **Use riprap around the inlet and outlet of culverts to prevent water from eroding and undercutting the culvert.** Use filter fabric or a filter layer of gravel under the riprap. Consider using flared-end culvert sections, where appropriate.
- **Keep culverts clear and free of debris so that water can pass unimpeded at all times.** This is especially important in areas where beaver are present. Consider using a bevel cut culvert to facilitate debris removal. A bevel cut requires a longer culvert than a flat cut.

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ABOVE: Fords are best suited to shallow streams with a firm rock or gravel streambed.

Stream Crossing BMPs for Fords

BMPs

- **Use fords for crossing dry streambeds or where fording would cause minimal water quality impacts.**
- **Locate fords where stream banks are low.**
- **Place fords in areas with a firm rock or gravel streambed.** Install stabilizing materials like reinforced concrete planks, crushed rock, riprap, or rubber mats on streambeds, if needed.

Temporary Stream Crossing BMPs

BMPs

- **Use temporary stream crossings such as timber mats, pole fords, or frozen fords when appropriate.**
  - Timber mats can span the width of smaller streams and are easy to install with a skidder or forwarder. Timber mats can be used in any season.
  - Pole fords may be used in small streams by placing poles (or small logs) side by side on the streambed. Pole fords must be removed immediately after use. Remove any debris before the upstream end becomes clogged and impedes stream flow.
  - Frozen fords are used when the ice is thick enough or the streambed is frozen enough to support equipment and protect the streambed.
- **Anchor temporary structures on one end with a cable or other device so they do not float away during high water.** Install them so they can be easily removed when no longer needed, regardless of season.

Kim Lemke, DNR

LEFT: Timber mats are used here as part of an ice bridge.

Shelly Wizochalski, DNR

LEFT: Timber mats provide a temporary stream crossing on this skid trail.

RESOURCES

DNR Waterway and Wetland Permits

- Contains permit information and application packets for stream crossings
- http://dnr.wi.gov/waterways/

Fish Friendly Culverts

- Discusses considerations for the design, installation, and maintenance of culverts that can protect both roads and fish
- http://clean-water.uwex.edu/pubs/pdf/shore.fishfriendly culverts.pdf

Forest Management Practices: Crossing Options Series (University of Minnesota Extension Service Publications #1-16)

- Provides guidance on stream crossing options that can minimize the impact to water quality and fish habitat, including temporary structures that can be reused at other sites
- http://dnr.wi.gov/forestry/Usesof/bmp/bmpownerguides.htm#4

Portable Timber Bridges as a Best Management Practice in Forest Management (USDA Forest Service Publication #NA-TP-04-04)

- Provides information on portable timber bridges and includes design and cost information, installation advice, and a list of portable timber bridge manufacturers
- http://na.fs.fed.us/pubs/misc/bmp/timber_bridges_bmp.pdf

Temporary Stream and Wetland Crossing Options for Forest Management (USDA Forest Service Publication #NC-202)

- Reviews different options for temporary stream and wetland crossings, including cost and design considerations
- http://www.ncrs.fs.fed.us/epubs/gtr202/

Temporary Stream Crossings for Forestry: A Directory of Available Structures (DNR Pub FR-378)

- Describes types of temporary stream crossings and provides a directory of agencies with crossings available for use or loan
- http://dnr.wi.gov/forestry/publications/pdf/FR-378.pdf

Timber Harvesting

CHAPTER 6

Maine Forest Service

ABOVE: Use existing skid trails if they provide the best long-term access

Carmen Wagner, DNR

ABOVE: Logs are sorted and stockpiled at landings to be loaded onto trucks

Timber harvesting includes felling trees and transporting logs on skid trails to a landing. Skid trails are temporary travel-ways for logging equipment to transport felled trees or logs. Skid trails are not intended to be used by over-the-road vehicles.

At the landing, products are sorted and loaded onto trucks for transport to a mill or other facility. Landings may be permanent or temporary features. If permanent, they may also be used as parking areas or wildlife openings.

If skid trails or landings require excavation and construction, follow the BMPs in Chapter 4: Forest Roads. Stream crossing are discussed in Chapter 5.

Landing BMPs

BMPs

- **Locate landings on frozen ground or on firm well-drained soils that have a slight slope or that have been shaped to promote efficient drainage.** Landings may need to be crowned to promote drainage.
- **Use existing landings if possible.** Close existing landings in riparian management zones, wetlands, and wetland filter strips unless construction of new landings will cause greater harm to water quality than using the existing landings.
- **Locate residue piles (sawdust, chipping residue, and other material) away from areas where runoff may wash residue into lakes, streams, or wetlands.**

Carmen Wagner, DNR

ABOVE: A well-draining landing on sandy soils

Skid Trail BMPs

BMPs

- **Where possible, keep skid trail grades less than 15%.** Where steep grades are unavoidable, break the grade, install drainage structures, and use soil stabilization practices (as described in Chapter 4: Forest Roads) where needed to minimize runoff and erosion. Grades greater than 15% should not exceed 300 feet in length.
- **Use existing skid trails if they provide the best long-term access.** Consider relocating existing skid trails if access can be improved and environmental impacts lessened

RIGHT: Tracked equipment can help minimize soil compaction

Carmen Wagner, DNR

RIGHT: Seeded and mulched landing

Maine Forest Service

General Timber Harvesting BMPs

In addition to the BMPs in this chapter, also refer to Chapter 7: Riparian Management Zones and Chapter 8: Wetlands.

BMPs

- **Limit the length and number of skid trails, landings, and stream crossings to the minimum necessary for conducting the harvest operation and to meet the landowner's objectives.** See discussion on balancing transportation needs in Chapter 4: Forest Roads.
- **Whenever possible, winch logs up steep slopes if conventional skidding could cause erosion that affects water quality.**
- **Avoid operating equipment where excessive soil compaction, rutting, or channelized runoff may cause erosion that affects water quality.** The use of low ground pressure equipment or other techniques may allow operations to continue.
- **Fill in ruts, apply seed and mulch, and install sediment control structures and drainage structures on skid trails and landings where needed to prevent erosion and sedimentation into surface waters.** See the Drainage Structures section and Soil Stabilization section of Chapter 4: Forest Roads.
- **Inspect soil stabilization practices periodically during and after harvest operations to insure that they are successful and remain functional.** Follow BMPs in the Road Maintenance section of Chapter 4: Forest Roads.
- **Do not dispose of or pile slash in areas where runoff may wash slash into lakes, streams, or wetlands.**
- **For winter harvesting, mark stream channels, dry washes, and existing culvert locations before snowfall.**

Dry Wash BMPs

Dry washes are incised, often v-shaped, hillside gullies experiencing active erosion. Dry washes are common along the steep slopes of southwestern Wisconsin's Driftless Area and Lake Superior's coast. Occasionally, conditions may also lead to the development of dry washes in other parts of the state.

Found in steep, hilly landscapes, large amounts of sediment can be swiftly eroded from dry washes and deposited elsewhere. The cause of dry washes can generally be traced back to man-made changes in the landscape above the dry wash. In southwest Wisconsin, they are commonly found on wooded slopes below agricultural fields, pastures, and ditch culverts. Dry washes are not found in flat areas.

Dry washes are not streams. They only receive water flow as surface runoff from snowmelt and rainstorms. They receive little to no flow from springs or seeps. If springs or seeps are present, the feature is more likely a stream with associated aquatic plants and animals, rather than a dry wash.

Dry washes are actively experiencing soil erosion. If the stability of the dry wash is compromised by equipment, this can lead to more erosion, causing the dry wash to widen, deepen, and progress further uphill (headcutting).

To differentiate dry washes from streams, ravines, valleys, and other landforms, consider the following:

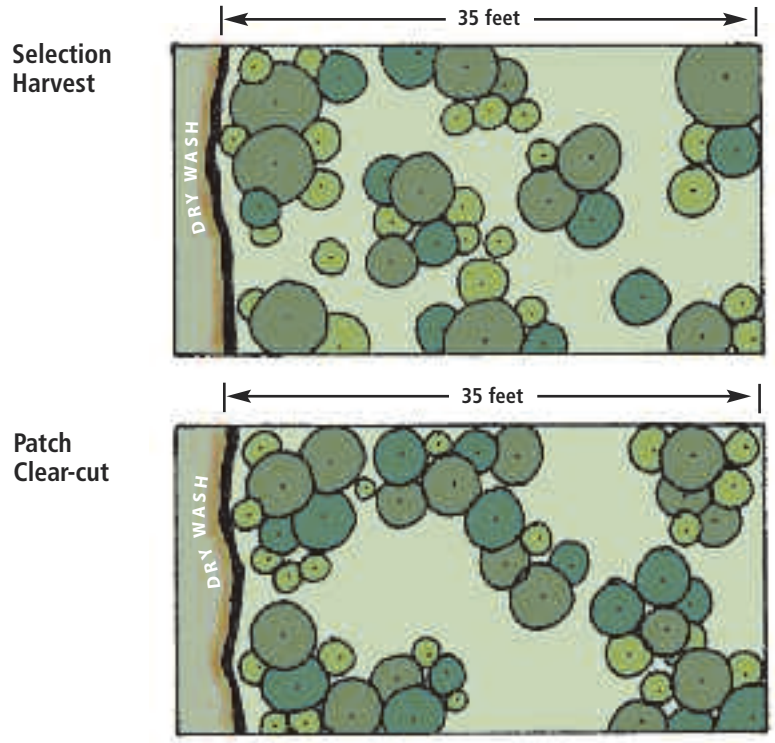
- Dry washes are not identified on topographical maps.
- Dry washes have deeply cut, steep sides.
- Dry washes have bare, eroding soil.
- Dry washes show signs of active erosion by concentrated water flow.

The following BMPs apply within 35 feet of each side of dry washes. The goal is to allow landowners to harvest timber while preventing further erosion in the dry wash during forest management activities. Selection harvest or patch clear-cut prescriptions are preferred because the deep root systems of the retained trees will help to stabilize the banks of dry washes. Patch clear-cuts will still allow enough light penetration to encourage regeneration of oak and aspen. It is possible to harvest timber at the edge of the dry wash.

BMPs

- **Use selection harvests or patch clear-cuts within 35 feet of the dry wash to promote tree species appropriate to the site.** No more than 50% of the area within 35 feet should be clear-cut.
- **Avoid locating roads and landings within 35 feet of the dry wash unless necessary for crossings.** To the extent possible, avoid crossing the dry wash with equipment during harvesting operations. For crossings, follow the recommendations in Chapter 5: Stream Crossings.
- **Operate wheeled or tracked equipment within 15 feet of the dry wash only when the ground is frozen or dry.** Minimize equipment activity around head of the dry wash in order to prevent further uphill progression (head-cutting) of the dry wash.
- **Do not harvest fine woody material within 15 feet of the dry wash.** Note: This BMP may be modified for specific site conditions, for specific operational issues, or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in Wisconsin's Forestland Woody Biomass Harvesting Guidelines.
- **Minimize soil exposure and compaction to protect ground vegetation and the duff layer.**
- **Avoid cabling logs across the dry wash, where feasible, to prevent damage to the banks of the dry wash.**

Harvest Options in 35-foot Dry Wash Management Zone



Note: No more than 50% of the dry wash management zone should be clear-cut.

Craig Hollingsworth, DNR

ABOVE: Dry wash in Driftless Area

Stabilizing a dry wash often requires addressing runoff problems outside of the dry wash. Many times the source of these problems is agricultural lands or roads, which is beyond the scope of this field manual. Your County Land Conservation Department may be able to provide some direction on what actions you can take to repair a dry wash.

A Closer Look at Timber Havesting Challenges in the Lake Superior Clay Plain

Along Lake Superior's southern shore stretches a red clay plain. The plain is a mixture of red clay and sand that creates an unstable environment that easily erodes.

Significant amounts of runoff and erosion can present a number of problems. When the volume and velocity of runoff is more than a stream can withstand, its banks can collapse and wash downstream. As the sand settles out, it can cover gravel spawning beds and fill deep holes used by fish.

DNR file

RIGHT: The streambanks in this area of the state are extremely susceptible to in-stream erosion.

When planning a timber harvest, consider how much timber harvesting is occurring, both on your individual property and within the watershed. Some considerations when planning a timber harvest in the red clay plain include:

- **Consider the amount of land that is in young forests and open lands in the area around the timber harvest.** Young forests are stands of trees less than 15 years old and open lands include fields and pastures. Extensive amounts of young forests and open lands in a watershed can increase the volume of runoff and the potential for streambank erosion.
- **Plan the layout of a timber sale so that uncut stands of trees will intercept runoff from harvested areas.**
- **Promote tree species that can be harvested by individual or group selection. These types of harvests should be a minimum of 15-20 years apart.**
- **Maintain larger, longer-lived tree species in a significant portion of riparian areas.**

RESOURCES

Managing Woodlands on Lake Superior's Red Clay Plain: Slowing the Flow of Runoff (DNR Pub FR-385)

- Provides recommendations on how to minimize erosion in the red clay plain during forestry activities
- http://dnr.wi.gov/forestry/publications/pdf/FR-385.pdf

Wisconsin Forest Management Guidelines, Chapter 13: Timber Harvesting (DNR Pub FR-226)

- Reviews planning, design and operational considerations when harvesting timber.
- http://dnr.wi.gov/forestry/Publications/Guidelines

CHAPTER 7

Riparian Management Zones

Carmen Wagner, DNR

ABOVE: RMZ on the Plover River

Riparian management zones (RMZs) are areas next to lakes and streams, where forest management practices are modified to protect water quality, fish habitat, and other aquatic resources. These areas are complex ecosystems that provide food, habitat, and movement corridors for aquatic (water) and terrestrial (land) species. In fact, 80% of the endangered and threatened species in Wisconsin spend all or part of their lives in these areas. Besides their wildlife habitat value, RMZs are crucial in helping to minimize the effects of nonpoint source pollution on adjacent surface waters.

Riparian management zones help to:

- **Filter sediment and nutrients from runoff.**
  As runoff flows over the soil and duff layer (needles, leaves, and decaying matter), it can slow and drop sediment that it is carrying. This settling process minimizes the amount of sediment and nutrients that reaches lakes and streams.
- **Allow water to soak into the ground.**
  The leaves, twigs, and stems of low growing vegetation and the duff layer in RMZs slow surface runoff, allowing water to soak into the ground. This helps to reduce peak flow levels in streams. It is also replenishes groundwater, helping to maintain lake levels and stream flows.
- **Stabilize lakeshores and streambanks.**
  The roots of trees and plants along lakes and streams can reduce soil erosion by holding soil in place, making it more difficult for waves, currents, and runoff to wash the soil away. Plants also intercept rainfall, reducing the impact of raindrops on bare soil and decreasing erosion.

- **Shade streams.**
  Streamside trees offer shade, keeping the water from becoming too warm for aquatic life in the summer. As water temperatures rise, dissolved oxygen levels decrease. Maintaining water temperatures are especially important in cold water trout streams.
- **Provide food and habitat for aquatic organisms.**
  Fallen leaves and twigs are the base of the food chain for aquatic organisms in small forest streams. Large woody debris, including logs and branches, provide critical habitat for fish, aquatic organisms, and terrestrial animals.

Regulations

Timber harvesting next to lakes and streams must be consistent with local zoning ordinances. Chapter NR 115, Wis. Admin. Code, establishes statewide minimum standards for cutting trees and shrubs in shoreland areas to protect natural scenic beauty, control erosion, and reduce the flow of sediment and nutrients from the shoreland area. Every county has a shoreland zoning ordinance which addresses vegetation management and other activities near lakes and streams. Many cities, villages, and towns have also adopted ordinances with shoreland management provisions. Before conducting any shoreland harvesting, contact your local zoning offices for permit and regulation information. Permit and regulatory information can be found in Appendices A and B. Contact information for county zoning offices can be found in Appendix C.

RIGHT: Forested shoreline in Vilas County

Carmen Wagner, DNR

Riparian Management Zone Categories

The recommended riparian management zone widths for lakes and streams are:

RMZ Width	Applies to:
RMZ = 100 feet	• Lakes • Designated trout streams (regardless of width) • Streams 3 feet wide and wider
RMZ = 35 feet	• Streams less than 3 feet wide
RMZ = 35 feet	• Streams less than 1 foot wide

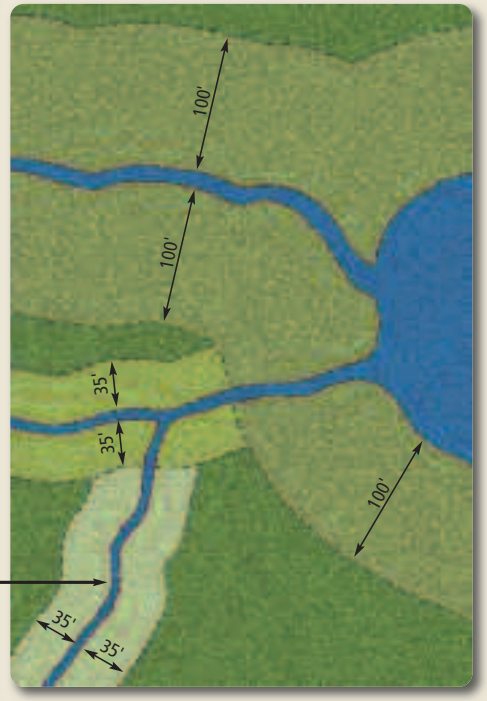
Riparian Management Zone (RMZ) Categories

There are three RMZ categories:

Lakes, designated trout streams and streams 3 feet wide and wider:
RMZ = 100 feet

Streams less than 3 feet wide:
RMZ = 35 feet

Streams less than 1 foot wide:
RMZ = 35 feet



NOTE: The RMZ width is measured along the lay of the land (the linear distance along the ground). It is not a horizontal distance, unless the ground is level.

The recommended RMZ width starts at the ordinary high water mark (OHWM) and is measured along the lay of the land (the linear distance along the ground). It is not a horizontal distance, unless the ground is level. Using best professional judgment, the width of the RMZ and associated BMPs may be modified to ensure water protection or if water quality will not be impacted. It is important to remember that water quality broadly encompasses chemical, physical, and biological characteristics of lakes and streams – it is not just water clarity.

Carmen Wagner, DNR

LEFT: RMZ below the recommended 60 s.f./acre basal area

Carmen Wagner, DNR

LEFT: RMZ with 60 to 80 s.f./acre basal area

A wider RMZ width may be needed on sites that exhibit one or more of the following site conditions:

- Steep slopes
- Long, continuous slopes
- Highly erodible soils
- No ground cover or duff layer
- Intensive soil disturbance near the RMZ
- Unique or sensitive waters

A narrower RMZ width may be suitable on sites that exhibit the following site conditions:

- Flat terrain
- Short slopes
- Stable or undisturbed soils
- Dense groundcover vegetation
- Soils with high infiltration rates

For the purposes of forest management, marking RMZs and the different zones within RMZs is discretionary based on timber stand characteristics, harvest prescription, forester preference, and logger experience.

Carmen Wagner, DNR

LEFT: Harvesting is allowed within RMZs

A Closer Look at **Measuring Stream Width**

Stream width is measured at the ordinary high water mark (OHWM). The OHWM is the point on the stream bank where the presence and action of the water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation, or other easily recognized characteristic.

The width of the stream should be measured at a straight channel segment within the management area. The ideal location to measure stream width is an area that is representative of the stream throughout the management area. Do not measure the width at the stream's widest points, which are often found in the bends of stream channels.

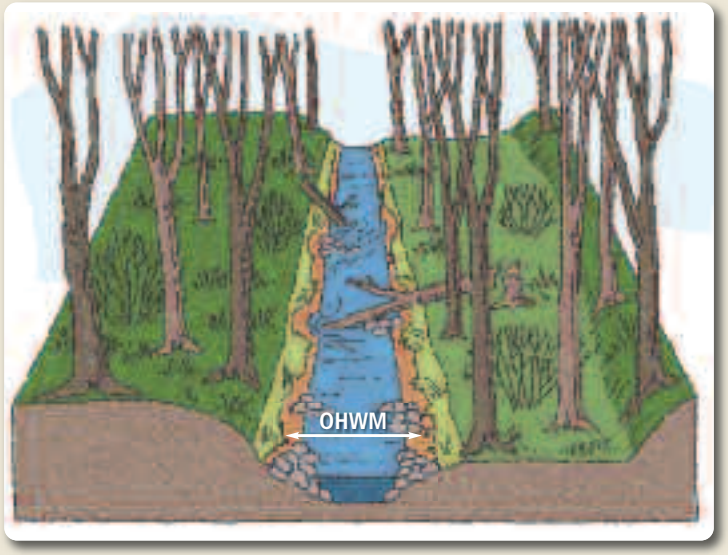
If the stream has recently been dammed by a beaver, go upstream or downstream to an area outside of the influence of the beaver dam to determine the stream width. Stream crossings, especially if undersized, can also cause a stream to widen. Go at least 100 feet upstream or downstream of a stream crossing to get a more representative measurement.

Dennis Pratt, DNR

ABOVE: Recent beaver dam

Carmen Wagner, DNR

How to Measure Stream Width



Stream width is measured at the ordinary high water mark (OHWM).

The width of the stream should be measured at a **straight channel segment** within the management area. When measuring the stream width, it should be in an area that **reflects the character of the stream** throughout the management area.

Ordinary High Water Mark: The point on the bank where the presence and action of water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation or other easily recognized characteristics.

If the stream is transitioning from a small stream (less than 3 feet wide) to a larger stream (more than 3 feet wide), then the RMZ width should transition from 35 feet to 100 feet consistent with the character of the stream.

BMPs Common to All RMZ Categories

The following BMPs apply in all RMZs.

BMPs

- **Locate roads outside the RMZ unless necessary for stream crossings.** For crossings, follow the recommendations in Chapter 5: Stream Crossings.
- **Locate landings outside the RMZ.**
- **Do not dispose of or pile slash within the RMZ. Slash from trees harvested within the RMZ may remain in the RMZ.** Keep slash out of lakes, streams, and areas where it may be swept into the water.
- **Minimize soil exposure and compaction to protect ground vegetation and the duff layer.**

RIGHT: Roads located outside the RMZ

DNR file

RIGHT: Red line marking RMZ

Carmen Wagner, DNR

BMPs for Lakes, Designated Trout Streams, and Streams 3 Feet Wide and Wider

Carmen Wagner, DNR

The RMZ for these waters is a strip of land running along the shoreline of a lake and on each side of a stream. The RMZ begins at the OHWM and extends a minimum of 100 feet landward. The 100-foot wide RMZ applies to designated trout streams, regardless of width. The DNR maintains a county-by-county listing of all designated trout streams, available at: http://dnr.wi.gov/fish/species/trout.

BMPs

- **Do not operate wheeled or tracked equipment within 15 feet of the ordinary high water mark except on roads or at stream crossings.**
- **Operate wheeled or tracked equipment within 15 to 50 feet of the ordinary high water mark only when the ground is frozen or dry.**
- **Do not harvest fine woody material within 50 feet of the ordinary high water mark.** Note: This BMP may be modified for specific site conditions, for specific operational issues, or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in Wisconsin's Forestland Woody Biomass Harvesting Guidelines.
- **Use selection harvests and promote long-lived tree species appropriate to the site.** Long-lived hardwood species include sugar maple, red maple, basswood, cottonwood, white ash, black ash, elm, and oak. Long-lived conifer species include eastern hemlock, white pine, red pine, and white cedar.
- **Harvesting intervals should be a minimum of 10 years.**
- **Harvesting plans should leave at least 60 square feet of basal area per acre in trees 5 inches DBH (diameter at breast height) and larger, evenly distributed.**
- **Develop trees 12 inches DBH and larger.**

BMPs for Streams Less Than 3 Feet Wide

The RMZ for these waters is a strip of land on each side of a stream. The RMZ begins at the OHWM of the stream and extends a minimum of 35 feet landward.

BMPs

- **Operate wheeled or tracked equipment within 15 feet of the ordinary high water mark only when the ground is frozen or dry.**
- **Do not harvest fine woody material within 15 feet of the ordinary high water mark.** Note: This BMP may be modified for specific site conditions, for specific operational issues, or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in Wisconsin's Forestland Woody Biomass Harvesting Guidelines.
- **Use selection harvests and promote long-lived tree species appropriate to the site.** Long-lived hardwood species include sugar maple, red maple, basswood, cottonwood, white ash, black ash, elm, and oak. Long-lived conifer species include eastern hemlock, white pine, red pine, and white cedar.
- **Harvesting intervals should be a minimum of 10 years.**
- **Harvesting plans should leave at least 60 square feet of basal area per acre in trees 5 inches DBH and larger, evenly distributed.**

RIGHT: Stream less than 3 feet wide

Jim Kloslewski, DNR

BMPs for Streams Less Than 1 Foot Wide

The RMZ for these waters is a strip of land on each side of a stream. The RMZ begins at the OHWM of the stream and extends a minimum of 35 feet landward.

BMPs

- **Operate wheeled or tracked equipment within 15 feet of the ordinary high water mark only when the ground is frozen or dry.**
- **Do not harvest fine woody material within 15 feet of the ordinary high water mark.** Note: This BMP may be modified for specific site conditions, for specific operational issues, or to meet specific management objectives if water quality will not be impacted. Additional guidelines can be found in Wisconsin's Forestland Woody Biomass Harvesting Guidelines.

Joe Kovach, DNR

ABOVE: Harvesting fine woody material

A Closer Look at **Managing RMZs Dominated by Aspen**

Jeff Martin, DNR

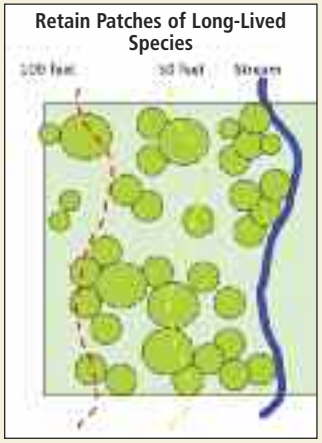
Aspen is a short-lived tree species with a rotational age of generally 40 to 65 years old in Wisconsin. The most common way to regenerate aspen is with a clear-cut, where most of the trees are cut. When aspen is the dominant cover type within an RMZ, a conflict may result in terms of managing for regeneration of aspen and managing for riparian functions. This occurs because maintaining at least 60 square feet of basal area per acre of trees will help to ensure that there are enough trees to shade streams, stabilize shorelands, and provide food and habitat for aquatic organisms, but it may also decrease the regeneration or sprouting of aspen in the RMZ.

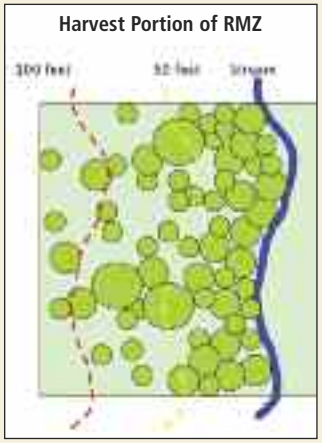
So what can you do if you have an RMZ dominated by aspen? First, look for opportunities to manage for long-lived tree species. Are there clumps of white pine, sugar maple, or other species that can be retained? After you have identified those areas, then decide how to mark the aspen around those areas. One solution would be to clear-cut up to the RMZ, and then maintain a balance of patches with long-lived species and with clear-cut aspen within the RMZ. Another option is have the first 50 feet of the RMZ be a no-cut area and then gradually harvest more trees (decreasing the basal area retained) out to the 100 foot boundary of the RMZ. With either suggestion, the risk of blowdowns may be lowered by gradually transitioning the basal area retained, rather than having a hard edge between a clear-cut and an uncut area.

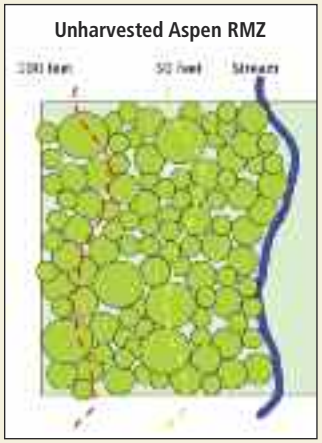
Carmen Wagner, DNR

ABOVE: Beaver lodge on stream with aspen-dominated RMZ

Management alternatives for aspen-dominated RMZs







Carmen Wagner, DNR

Another consideration with aspen management in RMZs is beavers. Aspen is one of the preferred foods for beaver. When beavers build dams and impound water, water temperatures in streams can rise. Beaver flowages can also destroy critical in-stream habitat features and flood out trees in riparian areas. On cold water streams in areas with high beaver populations, consider increasing the RMZ width and not harvesting within the RMZ. A 100-foot wide RMZ is often inadequate to discourage beavers, because beavers can travel more than 300 feet away from streams to find food.

In these situations and others, it is important to understand how water quality may be impacted by an activity to ensure that any BMP modification will provide equal or greater water quality protection. Every site is different and the vegetation, slopes, soils, landowner objectives, and other factors will ultimately influence management decisions.

RESOURCES

Do I Need a Permit for Harvesting Timber? (DNR Pub FR-379)

- Provides an overview of several regulations and permits that may apply during a timber harvest
- http://dnr.wi.gov/forestry/publications/pdf/FR-379.pdf

Trout Streams (DNR Pub FH-806)

- Provides a county-by-county listing of designated trout streams in Wisconsin
- http://dnr.wi.gov/fish/species/trout

Trout Stream Maps

- Offers maps of designated trout streams for each county in Wisconsin
- http://dnr.wi.gov/fish/species/trout/streammaps.html

RIGHT: Trout stream in Forest County

Kristin Lambert, DNR

Wetlands

CHAPTER 8

Thomas Meyer, DNR

ABOVE: Skunk cabbage in forested seep.

Section 23.32 (1), Wis. Stats., defines a wetland as "an area where water is at, near, or above the land surface long enough to be capable of supporting aquatic or hydrophytic vegetation and which has soils indicative of wet conditions." Wetlands can be very small, like a 500 square foot ephemeral pond, or very large, like the 32,000 acre Horicon Marsh. Wetlands often go by many names – swamps, bogs, low spots. There are actually over 30 different types of wetlands recognized in Wisconsin. Common types of forested wetlands are described in more detail in Chapter 2: Wisconsin's Water Resources.

Wetlands perform many functions, including valuable ecosystem services. Wetlands provide:

- **Fish and wildlife habitat.**
  Many animals, including nearly 40% of Wisconsin's bird species, live in or use wetlands for food, nest sites, and cover. One-third of the plants and animals on Wisconsin's state endangered and threatened list depend on wetlands.
- **Flood protection.**
  By storing runoff from heavy rains and snowmelt, wetlands can reduce flood peaks by as much as 60%. The EPA estimates that an acre of wetlands can store 1 to 1.5 million gallons of floodwater.
- **Water quality protection.**
  Wetlands can store and filter pollutants from surface water. Some wetlands can remove pollutants equivalent to the amount removed by a $5 million water treatment plant.

- **Groundwater recharge and discharge.**
  Some wetlands infiltrate surface water to replenish groundwater supplies. Other wetlands discharge groundwater to the surface, an important wetland function that helps to stabilize stream flows, especially during dry months.
- **Shoreline protection.**
  Shoreland wetlands act as buffers between land and water. They protect against erosion by absorbing the force of waves and currents. The roots of wetland plants further help by anchoring soil in place. Without this wetland buffer, the shoreline can become undercut and collapse.

Carmen Wagner, DNR

ABOVE: Wetland road needing repairs to protect wetland and support traffic

Wetlands can be difficult to work in because of the water and organic material in their soils. Wetland soils have low weight-bearing capacity, making them weaker than upland soils and more susceptible to rutting. In addition, it is common for water to be moving through the soil near the surface. The wetland BMPs are designed to prevent erosion, minimize changes to the surface and subsurface water movement, and to strengthen or increase the bearing capacity of the soil. Changes in a wetland, especially in water movement, can affect the health of the wetland ecosystem and the functions it performs.

Regulations

Activities in wetlands are often subject to municipal, county, state, and federal permits and regulatory requirements. Permit and regulatory information can be found in Appendices A and B. If you are building a road or conducting an activity in an area suspected to be a wetland, be sure to contact the following offices regarding applicable permits and regulations:

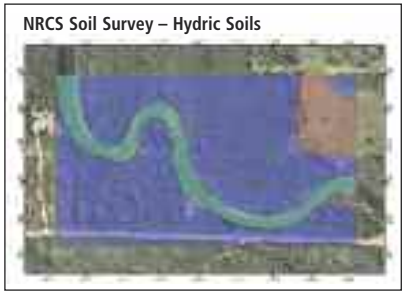
- your local zoning offices (town, village, city, and/or county),
- the local DNR water management specialist, and
- the local US Army Corps of Engineers (USACE) project manager.

Contact information for these offices can be found in Appendix C.

WI Wetland Inventory Map

Wetland Indicator Map

NRCS Soil Survey – Hydric Soils



Wetland Identification

There are a number of mapping products that can help you make a preliminary determination as to whether your project will affect wetlands, including:

- DNR Wisconsin Wetland Inventory maps
- DNR Wetland Indicator maps
- NRCS Soil Surveys

These maps can be reviewed at DNR and local zoning offices. They are also available on-line at the DNR and NRCS web-sites. Remember that maps are just guides and a field visit is necessary to confirm what the maps show. Wetland indicators to look for in the field include water, soils, and vegetation.

For purposes of forest management, marking wetland boundaries and wetland filter strips is discretionary based on timber stand characteristics, harvest prescription, forester preference, and logger experience.

General Wetland BMPs

BMPs

- **Whenever practical, avoid locating roads and landings in wetlands; otherwise use extreme caution.**
- **Whenever possible, forest management activities in wetlands should occur on frozen ground to minimize rutting.**
- **For activities in wetlands, consider allowing more flexibility regarding completion dates in timber sale contracts, allowing the logger time to complete logging activities during firm or frozen ground conditions.**
- **Do not dispose of or move upland slash into a wetland. Slash from trees harvested within the wetland may remain in the wetland.** Note: Using slash for a temporary wetland crossing to prevent rutting is encouraged and addressed in the Wetland Forest Roads, Skid Trails, and Landings Section of this chapter.
- **Keep slash out of open water.**
- **Only use pesticides labeled for use in wetlands.**
- **Whenever practical, avoid equipment maintenance and fueling in wetlands.** Otherwise, use extreme caution when doing so. Clean all spills promptly. See Chapter 9: Fuels, Lubricants, Waste, and Spills.

Wetland Filter Strip BMPs

A filter strip is an area of land located adjacent to a wetland that traps sediment and other pollutants from runoff before it reaches the wetland. Timber harvesting and other forest management activities can occur within both wetlands and filter strips. Care should be taken to prevent exposing soil that may erode into the wetland. The filter strip begins at the edge of the wetland and extends a minimum of 15 feet away from the wetland.

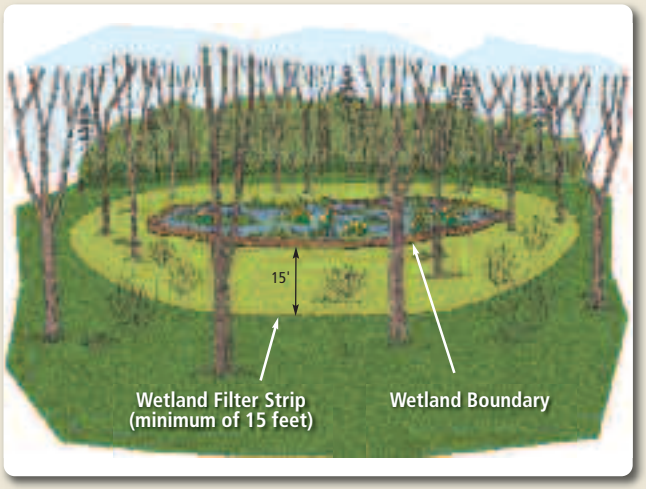
BMPs

- **Whenever practical, avoid locating roads and landings in the wetland filter strip; otherwise use extreme caution.**
- **Minimize soil exposure and compaction to protect ground vegetation and the duff layer in the wetland filter strip.**
- **Operate equipment in the wetland filter strip only when the ground is firm or frozen.**

Carmen Wagner, DNR

ABOVE: Harvesting can occur in wetlands and their filter strips

How to Measure Wetland Filter Strips



Filter strips are areas adjacent to wetlands that trap sediment and other pollutants from runoff before reaching wetlands.

A wetland filter strip begins at the edge of the wetland and extends a minimum 15 feet away from the wetland.

NOTE: The width of a wetland filter strip is measured along the lay of the land (the linear distance along the ground). It is not a horizontal distance, unless the ground is level.

Brick Fevold, DNR

ABOVE: Ephemeral pond

A Closer Look at **Protecting the Forest Floor**

In riparian management zones and wetland filter strips, the potential for soil erosion is minimized by taking care to protect the forest floor. The BMPs in these areas are designed to maintain an intact forest floor, prevent soil exposure, and minimize the potential for soil erosion.

The forest floor includes:

- Low growing plants that help to hold the soil in place
- Fallen branches, twigs, and leaves that slow water running over the ground
- Decomposed organic material that feeds soil microorganisms and helps to develop a well draining soil structure

Protecting the forest floor also helps to ensure a source of soil nutrients. Different sizes of organic material, from downed trees to large branches to small twigs, will decompose at different rates and provide soil nutrients over an extended period time.

Retaining downed trees, branches, and leaves is also important for wildlife habitat. For example, musk turtles lay their eggs under logs and four-toed salamanders nest in dense moss growing on downed trees that extend over open water.

Eunice Padley, DNR

ABOVE: Forest Floor

Wetland Road, Skid Trail, and Landing BMPs

Temporary roads, skid trails, and landings require firm or frozen ground. Any activities in wetlands must follow DNR and USACE regulations. Permanent and temporary roads must be built carefully to avoid restricting the natural water flow of the wetland under the road.

Scott Fischer, DNR

ABOVE: Temporary wetland crossing using slash

BMPs

- **Construct upland approaches to the wetland so the surface runoff is diverted away from the road approach prior to reaching the wetland.** See Drainage Structures section in Chapter 4: Forest Roads.
- **If landings are necessary in a wetland, build them to the minimum size required for the operation and to achieve the landowner's objective.**
- **Avoid operating equipment in areas of open water, springs, or seeps.**

Carmen Wagner, DNR

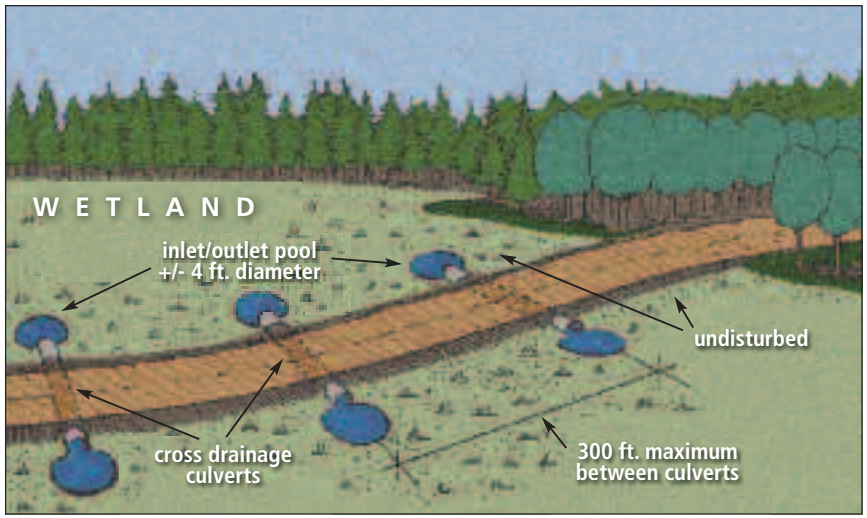
ABOVE: Open water during spring snow melt

Wetland Road, Skid Trail, and Landing BMPs (continued)

BMPs

- **Provide adequate cross-drainage in roads to minimize changes to natural surface and subsurface water flow in the wetland.**
  - For permanent roads with fill, use permeable fill material for at least the first layer of fill. Install culverts or bridges a maximum of 300 feet apart and at all natural drainages. Install at least one drainage structure in each wetland crossing.
  - For temporary roads, provide adequate cross-drainage at all natural drainages. Temporary crossing structures include timber mats, culverts, bridges, and porous organic material, such as corduroy, slash, or chunkwood. Temporary crossings should be removed promptly when the work is complete. If organic material is used, remove as much as feasible, given site and material conditions.

Wetland Road Construction



Carmen Wagner, DNR

LEFT: Temporary wetland crossing on frozen ground using slash

Joe Arington

LEFT: Permanent wetland crossing with geotextile

Joe Arington

LEFT: Permanent wetland crossing after construction with breaker run and gravel

Wetland Road, Skid Trail, and Landing BMPs (continued)

BMPs

- **Use low ground pressure equipment, such as wide tire or tracked equipment, if necessary to minimize rutting.**
- **Minimize rutting in wetlands by conducting forestry activities on firm or frozen ground that can support the equipment. To achieve this:**
  - Operate equipment on a day-to-day basis depending on weather conditions.
  - Consider using corduroy, slash, chunkwood, or timber mats to improve the soil's ability to support traffic.

  In the winter:
  - Compact snow, grass, and brush to promote frost penetration.
  - Monitor air temperatures daily. As air temperature rise above freezing, you may not be able to operate equipment beyond late morning without creating ruts. Soil frost begins to disappear when night temperatures stay above freezing for three or four consecutive nights.

  In the summer:
  - Operate equipment only when soils are dry enough to support equipment. Soil may become too wet after storms and extended wet spells.
- **Cease equipment operations before rutting becomes excessive.**

A Closer Look at **Excessive Rutting**

When the soil is not strong enough to support the weight of a vehicle, long depressions or ruts form. Rutting generally occurs when the soil pores are filled with water, essentially causing the soil to liquefy. The wheels of the equipment churn the soil and push it aside. Rutting can occur on both mineral and organic soils. In wet conditions, ruts may be formed by only a single pass of equipment. Ruts can also be observed after multiple passes of equipment during dry conditions.

Carmen Wagner, DNR

ABOVE: Tree damaged by logging equipment

The impacts of rutting can be widespread. Ruts can sever the roots and damage the trunks of individual trees, resulting in:

- Decreased nutrient uptake and declines in tree growth
- Entry points for disease and insects
- Trees more vulnerable to wind throw
- Tree mortality, if the damage is severe enough

Carmen Wagner, DNR

ABOVE: Excessive rutting in an ephemeral pond

Ruts can also affect forest productivity and forest health. When ruts compact and displace soil, soil aeration is reduced and infiltration of water is decreased, which ultimately degrades the rooting environment for plants. These disturbances may also create an environment that is more favorable to the introduction of weedy or invasive plants.

The hydrology or flow of water across a site can also be affected by rutting. If ruts cut across the natural flow of water, pockets of saturated soils or standing water may be created on the uphill side. This may cause trees or other plants to drown out. Downhill from the ruts, vegetation may suffer from drier conditions. If the ruts follow the flow of water, they can act as ditches and water may be directed more quickly off of the site, draining the area. In this case, erosion and sedimentation are also likely to occur.

Scott Fischer, DNR

ABOVE: Excessive rutting in a pine plantation

It is difficult to precisely state when rutting becomes excessive. When determining whether rutting is excessive, it is important to place it in the context of that site, consider specific management objectives, and understand the related impacts. Is the rutting occurring on a forest road, where trees are not expected to regenerate and the ruts can easily be fixed later? Are the ruts in harvest areas, damaging existing trees and degrading conditions for seed germination? Is it in a wetland where equipment may make the problem worse trying to repair ruts? The thresholds for excessive rutting can vary. Often timber sale contracts will contain thresholds for excessive rutting.

First and foremost, steps should be taken to avoid and minimize the potential for rutting. In the publication Maintaining Soil Quality in Woodlands, you will find out how to identify areas sensitive to soil compaction, rutting, and erosion. It also goes over options for repairing or mitigating soil damage. Please note that it is not always possible to repair soil damage, so it is important to try to minimize the potential for soil compaction and rutting from the start.

Federal Requirements for Forest Roads in Wetlands

The following 15 federal BMPs are required for construction and maintenance of forest roads in order to qualify for the silvicultural exemption from a federal section 404 permit. The silvicultural exemption for forest roads is only applicable when the primary purpose of the road is silviculture. This list is written in lay language. For the exact language of the law, contact the USACE program manager in your area. For additional publications discussing this topic, refer to the Resources Section at the end of this chapter and Chapter 4: Forest Roads.

Federal BMPs

- ★ **Avoid filling wetlands if practicable alternatives exist – especially in breeding and nesting areas for migratory birds and spawning areas for fish.**
- ★ **Limit the number, length, and width of forest roads and skid trails to the minimum necessary to accomplish the forest management goals, consistent with topographic and climatic conditions.**
- ★ **Locate roads outside of riparian management zones (RMZs), except at stream crossings.**
- ★ **Place bridges or culverts in road fill to prevent constriction of expected flood flows – other design methods may also be appropriate.**
- ★ **Stabilize fill to prevent erosion and sedimentation – before, during, and after road construction.**
- ★ **Minimize the use of equipment in wetlands outside of the fill areas.**
- ★ **Minimize disturbance of wetland and aquatic vegetation during the design, construction, and maintenance of roads.**
- ★ **Design, construct, and maintain wetland crossings to avoid disrupting movement of fish and other aquatic species.**
- ★ **Use fill from upland sources whenever feasible.**

Federal Requirements for Forest Roads in Wetlands (continued)

Federal BMPs

- ★ **Place fill so as to not affect any threatened or endangered species and to prevent any adverse modification or destruction of critical habitat for these species.**
- ★ **Do not place fill near public water supply intakes.**
- ★ **Do not place fill in areas of concentrated shellfish production.**
- ★ **Do not place fill in National Wild and Scenic River Systems – in Wisconsin, these are portions of the Namekagon, St. Croix, and Wolf Rivers.**
- ★ **Use fill that is clean, non-erodible, and non-toxic.**
- ★ **Remove all temporary fill and restore disturbed areas to their original elevation.**

Carmen Wagner, DNR

ABOVE: *Carex crinita*, or fringed sedge, found in forested wetlands

RESOURCES

DNR Wetlands: Locating Wetlands

- Reviews steps in identifying wetlands and provides link to on-line wetland mapping resources
- http://dnr.wi.gov/wetlands/locating.html

Forest Roads and Wetlands: Evaluating Your Options (DNR Pub-408)

- Discusses forest road considerations and includes a checklist on the silvicultural exemption for forest roads.
- http://dnr.wi.gov/forestry/publications/pdf/FR-408.pdf

Forested Wetlands: Functions, Benefits and the Use of Best Management Practices (USDA Forest Service Publication #NA-PR-01-95)

- Offers detailed instructions on constructing forest roads in wetlands
- http://na.fs.fed.us/spfo/pubs/n_resource/wetlands/index.htm

Maintaining Soil Quality in Woodlands: A Lake States Field Guide (DNR Pub FR-409)

- Discusses how to indentify area sensitive to soil compaction, rutting and erosion. Offers methods to maintain soil quality and options for repairing or mitigating soil damage.
- http://dnr.wi.gov/forestry/publications/pdf/FR-409.pdf

NRCS Web Soil Survey

- Provides access to NRCS soil maps, soil data and other related information
- http://websoilsurvey.nrcs.usda.gov

Any spills should be properly cleaned up. Some spills may require reporting.

Photo by Carmen Wagner, DNR

Fuels, Lubricants, Waste, and Spills

Fuel, Lubricant and Waste BMPs

Maine DNR

ABOVE: Store waste and trash in leak-proof containers until disposal.

Logging, road building, and other forest activities require motorized equipment. Antifreeze, fuels, and lubricants used in machinery can potentially pollute lakes, streams, wetlands, and groundwater. Planning for forestry operations should include practices to handle solid and liquid wastes generated in the field.

The following BMPs will help to prevent nonpoint source pollution from fuels, lubricants, and wastes during forest management activities.

BMPs

- **Use biodegradable lubricants whenever practical.** Biodegradable lubricants are less toxic than other lubricants, but still need to be disposed of properly.
- **Maintain equipment regularly.** Check hoses and fittings to prevent leaks or spills.
- **Designate specific areas for equipment maintenance and fueling.** Locate these areas on level terrain, a minimum of 100 feet from lakes and streams.
- **Collect all waste lubricants, containers, and trash.** Store them in leak-proof containers until they can be transported off-site for recycling, reuse, or disposal at an approved site. Call your local DNR regional office for more information.
  Note: It is illegal to dump fuel and lubricants on the land or in the water in Wisconsin.
- **Separate all fluids and materials and keep them in different labeled containers** to avoid creating hazardous waste and expensive waste disposal. Call your local DNR regional office to determine if a waste is hazardous and how to dispose of hazardous waste.

Spill BMPs

Maine DNR

ABOVE: Fuel and maintain equipment on flat ground at least 100 ft. from lakes and streams to minimize threats from spills

Spills of fuel, lubricants, or pesticides during forest management operations can occur as a result of fueling, hydraulic hose breaks, mechanical damage, improper handling, accidents, or vandalism. Spills of hazardous substances that adversely impact or threaten to adversely impact public health, welfare, or the environment must be immediately reported to the DNR and cleaned up. During timber harvesting operations, a spill must be reported when:

- It is a gasoline spill of 1 gallon or more, or
- It is a diesel or hydraulic fluid spill of 5 gallons or more.

While it is not necessary to report spills of less than the above quantities, the spills still need to be cleaned up and disposed of properly. Equipment maintenance can prevent many spills.

The following BMPs are general guidelines for spills of fuel and lubricants used in forestry operations. These practices complement specialized training given to people using pesticides or hazardous materials.

BMPs

Maintain a spill containment and clean-up kit appropriate for the materials on the operation. At a minimum, a kit for petroleum products should include:

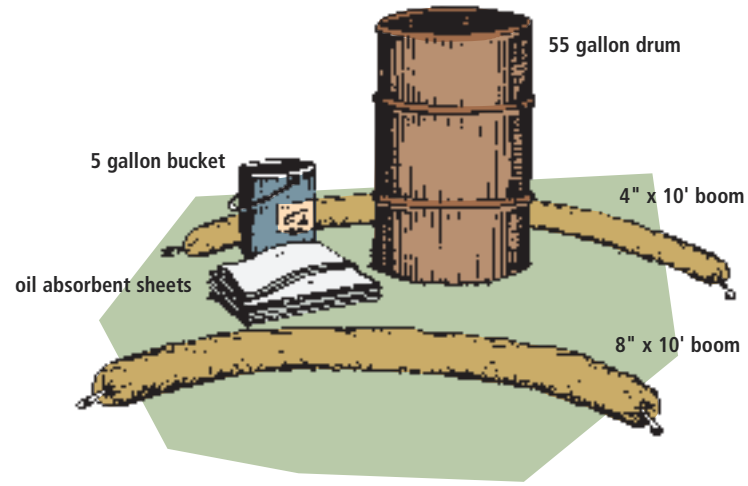
— Plugs and clamps to control a hydraulic line break

— A container to catch leaking fluid

— A shovel

— Oil absorbent sheets, sawdust or other materials to absorb spilled fluid.

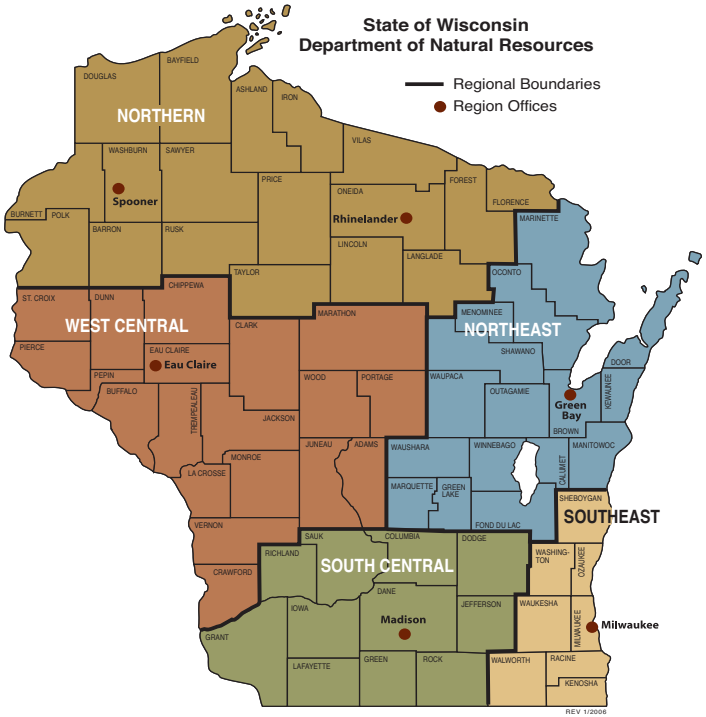
Items to have on hand for spill containment.



BMPs

If a spill should occur, do the following:

1. **Protect yourself and others.** Wear protective clothing and equipment appropriate for any hazardous materials on the operation. Avoid coming in contact with any toxic drift or fumes that may be released.
2. If you are able, **control the spill; stop the leak**.
3. If you are able, **contain the spill; keep it from spreading**. Shovel a dike around the spill. Use absorbent materials, such as sawdust or loose soil, to soak up the fluid. Place a bucket under the hydraulic hose break. Keep the spill from flowing into lakes, streams or wetlands.
4. **Isolate the spill material**.
5. **Report all hazardous substance spills immediately** to the Wisconsin 24-hour toll-free hotline: 1-800-943-0003. A reportable spill is 1+ gallons of gasoline or 5+ gallons of diesel.
6. **Contact your local DNR regional office** for disposal guidance.



RESOURCES

24-Hour Toll-Free Spill Emergency Hotline:

- Contact when a reportable spills occurs (1+ gallons of gasoline or 5+ gallons of diesel or hydraulic fluid)
- 1-800-943-0003

DNR Spill Response Coordinators

- Provide guidance on spill clean-up and can answer questions regarding reporting requirements
- Northeast Region: 920-662-5492
- Northern Region: 715-365-8959
- Southeast Region: 414-263-8685
- South Central Region: 608-275-3299
- West Central Region: 715-839-1604
- http://dnr.wi.gov/org/aw/rr/spills

Chemicals

CHAPTER 10

Chemicals commonly used in forest management include pesticides (insecticides, herbicides, and fungicides) and fertilizers. These chemicals are used to control insects, unwanted vegetation and diseases, and to enhance tree growth.

Jeff Martin, DNR

ABOVE: Rinse spray equipment in treatment areas to minimize spread of chemicals.

When used properly, chemicals should not affect water quality. However, when improperly applied, chemicals may cause problems if they drift over or flow into surface water. Chemicals can also contaminate groundwater if they leach through the soil into groundwater. Some chemical are labeled for use in or near lakes, streams, or wetlands. Use extra care when applying chemicals in riparian management zones and wetlands.

Integrated Pest Management (IPM) is a management strategy that uses a combination of manual, mechanical, biological, chemical, and preventative techniques to minimize the impact of insects, diseases, and unwanted vegetation. IPM may reduce dependence on the use of chemicals.

Anyone who has determined that pesticide applications are the appropriate tool to eliminate a pest on their land should consider becoming a certified pesticide applicator, if they plan to make the applications themselves. Wisconsin state law requires that anyone who will use (mix, load, or apply) a restricted-use pesticide, or anyone who will use ANY pesticide on a for-hire basis, must become certified. To learn more about becoming a certified pesticide applicator, please visit the Wisconsin Pesticide Applicator Training Program's website at http://ipcm.wisc.edu/pat.

The chemical BMPs below describe techniques to avoid contaminating surface water and groundwater. These guidelines complement local, state, and federal regulations governing the storage, sale, transportation, handling, and application of chemicals. By federal law, chemical users must follow Environmental Protection Agency (EPA) labels on pesticide containers.

General Chemical BMPs

BMPs

- **Maintain a spill containment and clean-up kit appropriate for the materials used on the operation and report all spills.** For more information, see the Spills Section in Chapter 9.
- **Follow all EPA label instructions on chemical containers.**
- **Apply chemicals only under favorable weather conditions.**
- **Calibrate spray equipment to apply chemicals uniformly and in the correct quantities.**
- **Check all equipment for leaking hoses, connections, and nozzles to prevent chemical leaks from equipment.**
- **Use chemicals in riparian management zones with guidance from a trained natural resource professional.**
- **Use spot-injection or stump treatment methods when applying chemicals not labeled for aquatic use in riparian management zones.**
- **Avoid applying herbicides in areas where the chemical can kill stabilizing vegetation on slopes, gullies, and other areas subject to erosion that drain into surface water.**
- **Mix and load chemicals outside of riparian management zones and, where practical, in upland areas.**
- **Rinse spray equipment and discharge rinse water only in areas that are part of the application site.**
- **Dispose of chemical containers according to label instructions.**

Jeff Martin, DNR

LEFT: Cool, calm days are often best for applying chemicals.

Aerial Chemical Application BMPs

BMPs

- **Hire a licensed aerial applicator.**
- **Identify and avoid riparian management zones and surface water** to prevent chemicals not labeled for aquatic use from drifting over open water or from accidentally being applied directly on the water.

RESOURCES

Department of Agriculture, Trade and Consumer Protection Licensed Chemical Applicator Search

- Maintains a list of aerial applicators licensed in Wisconsin
- http://www.kellysolutions.com/WI/Applicators/searchbyCategory.asp

Wisconsin Pesticide Applicator Training Program

- Provides manuals for training to become a Wisconsin-certified pesticide applicator and fact sheets on complying with complicated pesticide regulations
- http://ipcm.wisc.edu/pat

Roller chopping can help clean up the residual trees, slash, and brush on a site, possibly eliminating the need for herbicide treatments.

Photo by Jeff Martin, DNR

CHAPTER 11

Mechanical Site Preparation and Tree Planting

Carmen Wagner, DNR

ABOVE: Tree seedlings benefit from the reduced competition provided with proper site preparation.

Mechanical site preparation creates a favorable growing environment for tree seeds or seedlings. Effective site preparation should reduce competition from other vegetation and create a sufficient area of suitable growing sites, without causing excessive soil disturbance. However, using machinery to prepare the site and plant trees typically exposes soil, so proceed with care to avoid impacting water quality.

Common site preparation techniques include scarifying, shearing, raking, disking, and roller chopping. Select a technique based on specific site characteristics including soil, topography, vegetation, access, and distance to surface waters. Chemicals and prescribed burning may also be used for site preparation. BMPs for these management tools are listed in Chapters 10 and 12.

Avoid excessive soil disturbances and proceed with care to avoid impacting water quality.

Mechanical Site Preparation and Tree Planting BMPs

BMPs

- **Avoid operating mechanical site preparation and tree planting equipment on slopes greater than 30% that drain directly into a lake, stream or wetland.**
- **Operate mechanical site preparation and tree planting equipment on the contour where necessary to minimize erosion into a lake, stream, or wetland.**
- **Minimize raking in areas, or under conditions, in which soil could erode and enter a lake, stream or wetland. Two preferred practices are:**
  - **— Shear and rake when the soil is frozen.**
  - **— Rake lightly to remove only slash.**
- **Suspend operations during wet periods if equipment begins to cause excessive soil disturbance that may lead to erosion into a lake, stream or wetland.**
- **Deposit site preparation residues in stable locations outside riparian management zones and filter strips.**
- **Use patch scarification, low intensity prescribed burns, or manual site preparation in areas that are adjacent to a lake, stream or wetland, or areas that have steep slopes, erosion prone soils, or saturated soils that drain to surface water. Consider hand planting in these areas.**

RESOURCES

DNR Tree Planting Information: Site Preparation

- Reviews different site preparation techniques and provides informational videos
- http://dnr.wi.gov/forestry/Nursery/GeneralInfo/siteprep.htm

Prescribed Burning and Wildfire

CHAPTER 12

Prescribed burning reduces unwanted vegetation and logging debris in forests. It can also be used to prepare sites for tree planting or direct seeding. Prescribed burning also reduces the potential for destructive wildfires by limiting the accumulation of fuel material. Carefully plan all prescribed burns and clearly identify your objectives.

Fires generally have little effect on water quality if all of the fuel material, such as grasses, shrubs, and forest floor litter, is not consumed in an area. However, fires that do consume all of these materials can expose soil, leading to erosion and impacting water quality.

Always rely on trained and experienced personnel to plan and implement prescribed burns. The BMPs in this chapter are designed to complement professional training.

Contact the Wisconsin Department of Natural Resources (DNR) for more information.

Regulations

Before conducting a prescribed burn, check local fire regulations and obtain a burning permit from the Wisconsin DNR or your local municipal or township authorities, as needed.

Prescribed Burning BMPs

BMPs

- **Plan to control erosion after the burn to prevent sediment runoff to lakes, streams, and wetlands** (see the Post-Fire Maintenance section of this chapter).
- **Carefully select fireline locations and consider weather, fuel, soil, and topographic conditions** in and around the burn area to minimize impacts on water quality.
- **Avoid burns that remove the forest floor litter layer** to prevent exposing soil in riparian management zones and on slopes where eroded soil may wash into surface waters.
- **Avoid burning piles of slash in riparian management zones.**
- **Use natural or existing barriers** (e.g. roads, streams, lakes) when possible or use mowed, raked, and wet lines for firelines where bladed or plowed firelines will erode soil and degrade water quality.
- **Avoid plowed and bladed firelines in riparian management zones except where necessary to control wildfire.**
- **Where possible, locate bladed firelines on the contour.** Construct water bars as needed to direct surface water off firelines and into undisturbed forest cover. Recommended specifications for building water bars can be found in the Drainage Structures section in Chapter 4: Forest Roads.
- **Avoid applying chemical fire retardants over surface water.** Prevent chemical fire retardants from flowing into surface water.

Jeff Martin, DNR

LEFT: Forestry BMPs for water quality complement the training received by persons conducting prescribed burns.

Wildfire BMPs

When fighting wildfires, preventing harm to people and property should be the top priority. After containing the fire, address land rehabilitation needed to prevent or minimize nonpoint source pollution of lakes, streams, and wetlands.

DNR file

BMPs

- **Whenever possible, avoid applying chemical fire retardants over surface water.**

Carmen Wagner, DNR

Carmen Wagner, DNR

ABOVE: After 5 weeks, vegetation is resprouting at this site of a wildfire.

LEFT: Blading or disking fire breaks works well in areas where erosion will not threaten water quality.

Post-Fire Maintenance BMPs for Prescribed Burns and Wildfires

BMPs

- **Do not clean chemical application equipment in surface water or in locations that drain directly into surface water.**
- **Use erosion control measures for firelines that could erode soil into lakes, streams and wetlands.** Erosion control measures include revegetating bare soil (Soil Stabilization section in Chapter 4: Forest Roads) and installing water bars (Drainage Structures section in Chapter 4: Forest Roads). Placing sod back into plowed furrows at appropriate intervals can act as water bars.
- **Maintain soil stabilization practices until the site is fully revegetated and stabilized.**
- **Use mowing or other practices that do not expose soil as alternatives to blading or disking for maintaining firebreaks where erosion may degrade water quality.**

RESOURCES

Wisconsin Forest Management Guidelines, Chapter 17: Fire Management (DNR Pub FR-226)

- Describes considerations for wildfire management and prescribed burns.
- http://dnr.wi.gov/forestry/Publications/Guidelines

Permits

APPENDIX A

In addition to the BMPs described in this field manual, you should be aware of existing municipal, county, state, and federal permits and regulations relating to forest management and water quality. Many of these regulations are listed in Appendix B: Regulations. Other laws and regulations may apply and the list below should not be construed as complete. For more information on these permits, contact the appropriate office (listed in Appendix C) or refer to the regulatory website (provided below).

Local Permits and Notices

Burning Permits

These permits may be required by town, village, city, or county regulations. The phone numbers of county zoning offices can be found in Appendix C.

County Cutting Notices

Contact your local fire department, town chairperson, or local municipal official if you have any questions. Local ordinances may be more restrictive than state law.

Floodplain Zoning Permits

When working in a mapped floodplain, permits may be required for activities including installation of stream crossings and placement of wetland fill (such as for an approach to a stream crossing). The goal of these regulations is to prevent increases in flood elevations.

Shoreland and Shoreland-Wetland Zoning Permits

Permits may be required by shoreland or shoreland-wetland zoning ordinances for harvesting timber near the water, grading, placing fill in wetlands and other activities. Regulations vary by municipality. Special provisions exist on the Lower Wisconsin Riverway and the St. Croix River. The Lower Wisconsin Riverway extends from the dam at Prairie du Sac south to the Mississippi River. Information on the Lower Wisconsin

Riverway is available at: http://lwr.state.wi.us/ or by calling (608) 739-3188. Standards along the St. Croix River are available from municipal offices.

State Permits and Notices

Burning Permits

DNR annual burning permits are intended primarily for vegetative debris removal. They are issued to landowners for burning on the ground and in barrels. These no-cost permits are good for the calendar year and are non-transferable. More information is available at: http://dnr.wi.gov/forestry/fire/burning-rp.htm.

Cutting Notices and Reports

Landowners that are enrolled in the Managed Forest Law (MFL) Program or the Forest Crop Law (FCL) Program must file a cutting notice (part A of form) with the DNR at least 30 days before harvesting begins (except for cutting firewood for personal use). Within 30 days of the completion of the harvest, a report (part B of form) with cutting volumes must be filed with the DNR. For more information, contact your local DNR forester (see Appendix C) or refer to: http://dnr.wi.gov/forestry/ftax/.

Storm Water Permits

DNR storm water permits may be required when constructing, reconstructing or maintaining roads. Storm water permits are not required for forest roads that are used solely for silvicultural purposes, if certain standards are met. For multi-use roads, a storm water permit is needed when the construction of a new road or reconstruction of an existing road will disturb one or more acres of land or when maintenance of an existing road will disturb five or more acres. Contact your local DNR storm water specialist (see Appendix C) or refer to: http://dnr.wi.gov/runoff/stormwater/const.htm for more information about the DNR's Storm Water Program.

Waterway and Wetland Permits

DNR waterway and wetland permits are required for activities that affect lakes, streams, and wetlands. Common activities that occur during forest management that may require a permit include:

- stream crossings, including bridges, culverts, fords, timber mats, and pole fords
- wetland crossings
- grading more than 10,000 square feet on the bank of a lake or stream

For more information about waterway and wetland permits, contact your local DNR water management specialist (see Appendix C) or go to: http://dnr.wi.gov/waterways/.

Federal Permits

Waterway and Wetland Permits

The US Army Corp of Engineers (USACE) regulates activities occurring in waterways and wetlands, including the excavation and placement of fill. When building a road or trail through a wetland, a permit may be required from the USACE. An exemption for forest roads is available, but certain design, location, and use standards must be met to qualify for the exemption. Contact your local USACE program staff (see Appendix C) or visit the USACE web-site at: http://www.mvp.usace.army.mil/regulatory/.

Construction of forest roads are subject to various regulations.

Photo by Kristin Lambert, DNR

APPENDIX

B

Regulations

The list below contains regulations that relate to forest management and water quality. This is only a summary of laws and their provisions for your information. No warranty, expressed or implied, is made regarding the accuracy, adequacy, completeness, legality, reliability or usefulness of any information contained in this publication. To be certain of the accuracy of summaries, please consult the official language of the law that is listed.

Department employees shall not be held liable for any improper or incorrect use of the information contained in this publication. In no event shall the State of Wisconsin, the Department or Department employees be liable for any direct, indirect, incidental, special, exemplary, or consequential damages however caused and on any theory of liability, whether in contract, strict liability, or tort (including negligence or otherwise) arising in any way out of the use of this publication. Other regulations may also apply.

Local Laws and Ordinances

Local laws and ordinances can be obtained from municipal offices.

Wisconsin State Statutes

Wisconsin State Statutes can be viewed at:
http://www.legis.state.wi.us/rsb/stats.html.

Chapter 26, Wis. Stats.: **Protection of Forest Lands and Forest Productivity**

- **S. 26.03, Wis. Stats.** – Requires that any person cutting a forest product from a private forest file a cutting notice with the county clerk prior to any harvesting.
- **S. 26.12 (6), Wis. Stats.** – Any slash which falls into or is deposited in a lake or stream, when harvesting timber or other forest products, shall be immediately removed if, in the opinion of the department, such removal is in the public interest.

Chapter 28, Wis. Stats.: Public Forests

- **S. 28.04 (2), Wis. Stats.** – Assures that state forests practice sustainable forestry for a full range of benefits, including protection of soil, water quality, and aquatic wildlife.
- **S. 28.11 (1), Wis. Stats.** – Provides for the management of county forests, including production of forest products, watershed protection, and stabilization of stream flow.

Chapter 29, Wis. Stats.: Wild Animals and Plants

- **S. 29.601 (3), Wis. Stats. –** Prohibits throwing or depositing any deleterious substances, including oil, tar, refuse, debris, decayed wood, sawdust, and sawmill refuse, into waters of the state.
- **S. 29.604, Wis. Stats.** – Establishes regulations for endangered and threatened wild animals and plants. Exempts forestry practices from regulations regarding endangered and threatened wild plants.

Chapter 30, Wis. Stats.: Navigable Waters, Harbors and Navigation

- **S. 30.12, Wis. Stats.** – Requires permits to deposit material and place structures on the bed of navigable waterways.
- **S. 30.123, Wis. Stats.** – Requires permits for the construction of bridges and culverts over navigable waterways
- **S. 30.18, Wis. Stats.** – Requires permits and establishes standards for diverting water from lakes and streams.
- **S. 30.19 (1g)(3), Wis. Stats.** – Requires permits for grading or removing more than 10,000 square feet of topsoil from the banks of navigable waterways.
- **S. 30.195, Wis. Stats.** – Requires permits for changing the course or straightening navigable streams.
- **S. 30.27, Wis. Stats.** – Identifies the Lower St. Croix River from the dam near St. Croix Falls to its confluence with the Mississippi River as a river to include in the National Wild and Scenic Rivers Program and directs the department to establish zoning standards.

- **S. 30.29, Wis. Stats.** – Prohibits the operation of motor vehicles in any navigable waters, except for agricultural uses (including forest management) or when the water is frozen.
- **Ss. 30.40 – 30.49, Wis. Stats.** – Establishes the Lower Wisconsin Riverway.

Chapter 77, Wis. Stats.: Taxation of Forest Croplands

- **S. 77.80, Wis. Stats.** – Provides for the management of private forests, including production of forest products and watershed protection.

Chapter 94, Wis. Stats.: Plant Industry

- **Ss. 94. 67 – 94.715, Wis. Stats.** – Addresses the sale, handling and use of pesticides.

Chapter 281, Wis. Stats.: Water and Sewage

- **S. 281.20, Wis. Stats.** – Authorizes the department to order the abatement of nonpoint source pollution.

Chapter 287, Wis. Stats.: Solid Waste Reduction, Recovery and Recycling

- **S. 287.07, Wis. Stats.** – Establishes standards for proper disposal of lead acid batteries, waste oil, tires and other materials.

Chapter 292, Wis. Stats.: Remedial Action

- **S. 292.11, Wis. Stats.** – Requires notification of state and local authorities of spills of hazardous substances.

Wisconsin Administrative Codes

Wisconsin Administrative Codes can be viewed at:
http://www.legis.state.wi.us/rsb/code.htm.

Chapter ATCP 29, Wis. Admin. Code: Pesticide Use and Control

- Provides standards for use, storage, sale, and commercial application of pesticides.

Chapter NR 27, Wis. Admin. Code: Endangered and Threatened Species

- Contains standards for the take, transportation, possession, or sale of any wild animal or wild plant on the department's lists of endangered and threatened wild animals and wild plants.

Chapter NR 37, Wis. Admin. Code: Lower Wisconsin State Riverway

- Establishes management specifications for timber harvesting in Lower Wisconsin Riverway.

Chapter NR 103, Wis. Admin. Code: Water Quality Standards for Wetlands

- Provides wetland water quality standards and procedures for permitting activities within wetlands.

Chapter NR 115, Wis. Admin. Code: Wisconsin's Shoreland Management Program

- Contains the statewide minimum standards for county shoreland zoning ordinances, including the management of shoreland vegetation.

Chapter NR 116, Wis. Admin. Code: Wisconsin's Floodplain Management Program

- Establishes standards for floodplain zoning ordinances.

Chapter NR 117, Wis. Admin. Code: Wisconsin's City and Village Shoreland-Wetland Protection Program

- Requires cities and villages to adopt shoreland-wetland zoning ordinances, including provisions regarding silvicultural activities. Provisions for counties are found in Ch. NR 115, Wis. Admin. Code.

Chapter NR 118, Wis. Admin. Code: Standards for the Lower St. Croix National Scenic Riverway

- Contains standards for municipal zoning ordinances on the Lower St. Croix River to maintain its scenic characteristics.

Chapter NR 151, Wis. Admin. Code: Runoff Management

- Establishes runoff performance standards and practices designed to achieve water quality standards.

Chapter NR 216, Wis. Admin. Code: Storm Water Discharge Permits

- Provides criteria for activities requiring storm water permits.

Chapter NR 302, Wis. Admin. Code: Management of Wisconsin's Wild Rivers

- Provides standards for the management of state-designated wild rivers, including timber harvesting standards.

Chapter NR 320, Wis. Admin. Code: Bridges and Culverts In or Over Navigable Waterways

- Establishes permitting standards for bridges and culverts.

Chapter NR 706, Wis. Admin. Code: Hazardous Substance Discharge Notification and Source Confirmation Requirements

- Requires the hazardous spills be reported to the department and that actions be taken to contain, clean-up, and properly dispose of the hazardous substance.

Federal Law

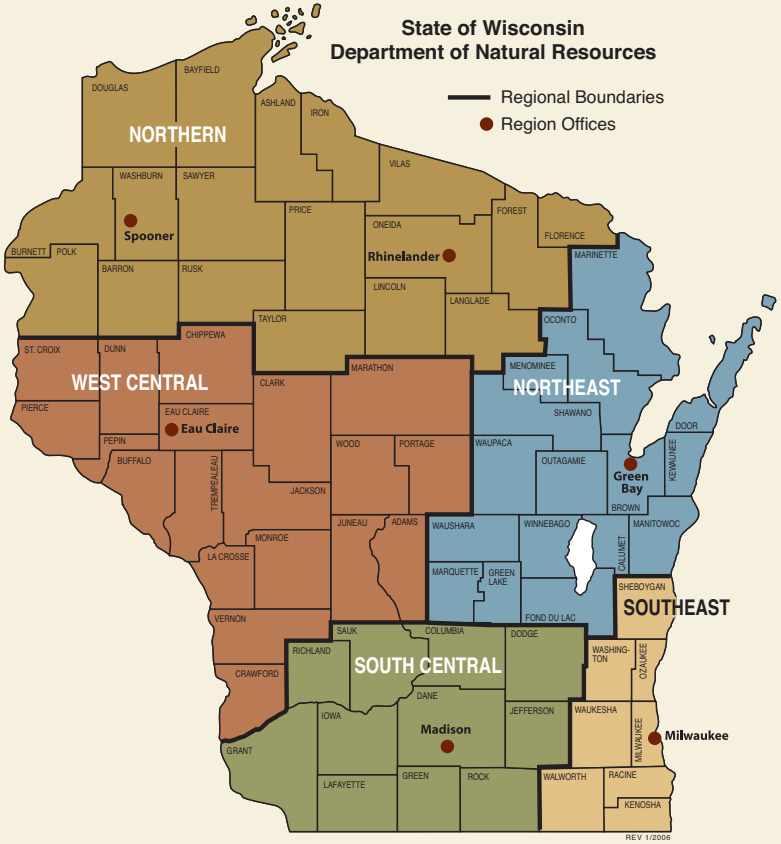
Section 404 of the Clean Water Act

- Establishes standards for permitting wetland alterations, including an exemption for normal silvicultural activities, including forest roads if certain design, location and use standards are satisfied.

Contact Information

APPENDIX C

Wisconsin Department of Natural Resources Region Offices



Central Office
101 S. Webster St.
P.O. Box 7921
Madison, WI 53707-7921
(608) 266-2111

Northeast Region
2984 Shawano Ave.
Green Bay, WI 54313-6727
(920) 662-5100

Northern Region
810 W. Maple St.
Spooner, WI 54801
(715) 635-2101

107 Sutliff Ave.
Rhinelander, WI 54501
(715) 365-8900

South Central Region
3911 Fish Hatchery Rd.
Fitchburg, WI 53711
(608) 275-3266

Southeast Region
2300 N. Martin Luther King, Jr. Dr.
Milwaukee, WI 53212
(414) 263-8500

West Central Region
1300 W. Clairemont Ave.
P.O. Box 4001
Eau Claire, WI 54702
(715) 839-3700

APPENDIX C: Contact Information

The following agencies can assist with planning, implementing, and maintaining various types of forestry BMPs. To determine the appropriate contacts for your project, look for references to these contacts in the portion of the manual applicable to your project.

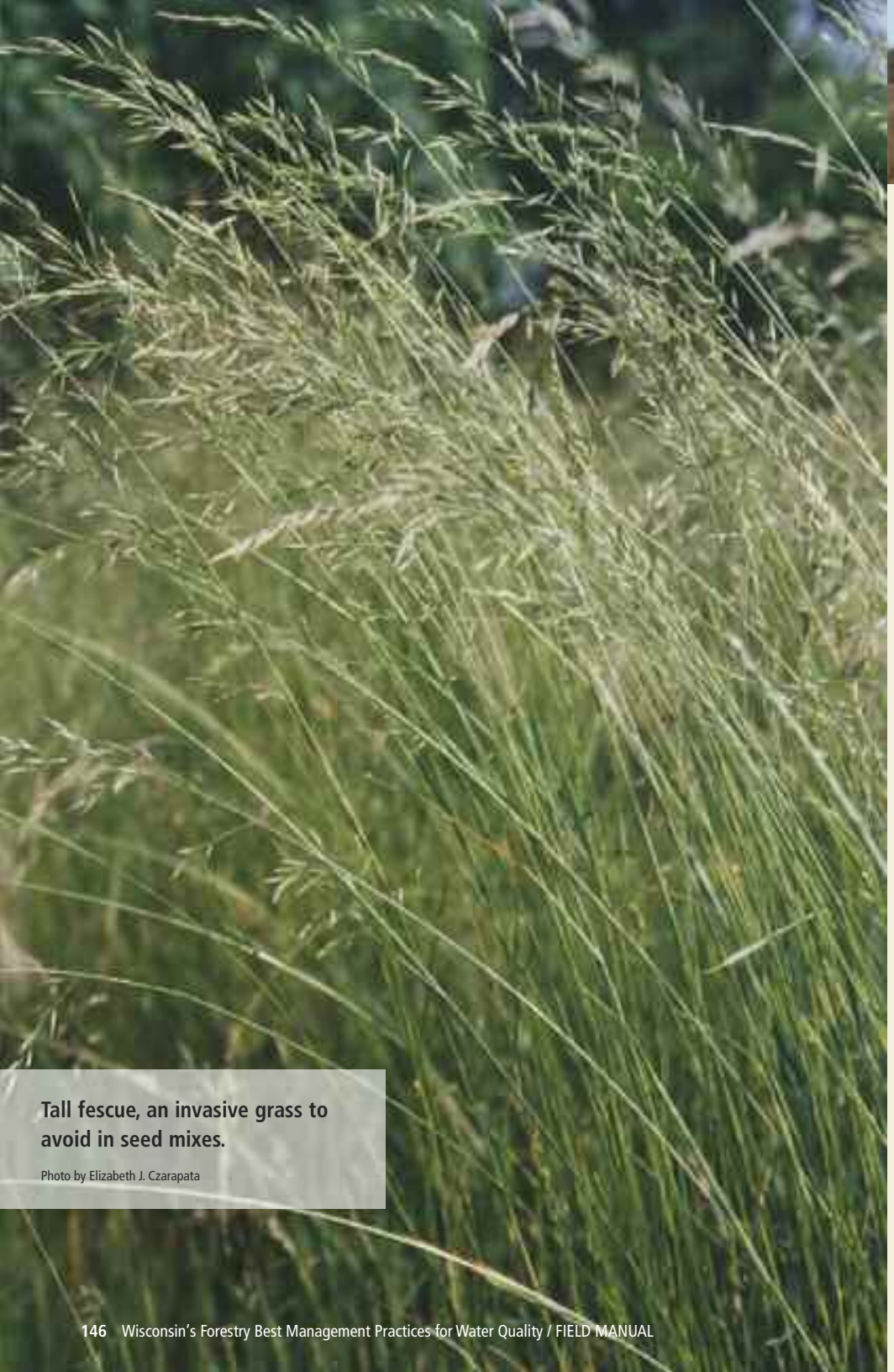
COUNTY	County Zoning	County Land Conservation Department	DNR Forester	DNR Water Management Specialist	DNR Storm Water Specialist	US Army Corps of Engineers	US Natural Resources Conservation Service	COUNTY
Adams	608-339-4222	608-339-4268	608-339-3386	715-421-7815	715-359-2872	715-345-7911	608-296-2815	**Adams**
Ashland	715-682-7014	715-682-7187	715-274-4141	715-685-2923	715-685-2926	715-934-2170	715-682-9117 ext 301	**Ashland**
Barron	715-537-6375	715-537-6315	715-637-6865	715-635-4097	715-635-4142	651-290-5380	715-537-5645	**Barron**
Bayfield	715-373-6138	715-373-6167	715-795-2565	715-685-2923	715-685-2926	715-934-2170	715-682-9117 ext 301	**Bayfield**
Brown	920-448-4490	920-391-4620	920-662-5156	920-662-5466	920-662-5441	920-448-2824	920-884-3910	**Brown**
Buffalo	608-685-6218	608-685-6260	608-685-6223	715-839-3769	608-785-9910	507-895-8059	608-685-4454 ext 101	**Buffalo**
Burnett	715-349-2138	715-349-2186	715-866-8201	715-635-4097	715-635-4142	715-934-2170	715-635-8228	**Burnett**
Calumet	920-849-1442 ext 226	920-849-1444 ext 248	920-832-2746	920-662-5466	920-832-1803	920-448-2824	920-849-1444	**Calumet**
Chippewa	715-726-7940	715-726-7920	715-726-7885	715-839-3769	715-684-2914 ext 123	651-290-5268	715-720-9083	**Chippewa**
Clark	715-743-5130	715-743-5102	715-743-5134	715-284-1424	715-359-2872	651-290-5268	715-743-3164	**Clark**
Columbia	608-742-9660	608-742-9670	608-635-8113	920-387-7878	608-275-3279	715-345-7911	608-742-5361	**Columbia**
Crawford	608-326-0294	608-326-0270	608-735-4672	608-785-9010	608-785-9910	507-895-8059	608-326-7179 ext 101	**Crawford**
Dane	608-266-4266	608-224-3730	608-275-3234	608-275-3208	608-275-3201	262-547-7869	608-224-3750	**Dane**
Dodge	920-386-3700	920-386-3660	920-387-7884	920-387-7878	608-275-3279	262-547-3064	920-386-9999	**Dodge**
Door	920-746-2323	920-746-2214	920-746-2880	920-662-5453	920-662-5461	920-448-2824	920-845-1360	**Door**
Douglas	715-395-1380	715-395-1266	715-376-2299	715-392-0803	715-685-2926	715-934-2170	715-682-9117 ext 301	**Douglas**
Dunn	715-232-1401	715-232-1496	715-232-1516	715-684-2914	715-684-2914 ext 123	651-290-5268	715-232-2614 ext 3	**Dunn**
Eau Claire	715-839-4743	715-839-6226	715-839-3782	715-839-3769	715-684-2914 ext 123	651-290-5268	715-839-5081 ext 3	**Eau Claire**
Florence	715-528-3206 ext 2	715-528-5940	715-528-4400	715-358-9214	715-762-1346	715-345-7911	715-362-5941 ext 111	**Florence**
Fond du Lac	920-929-3139	920-923-3033 ext 101	920-424-3056	920-424-7885	920-662-5461	920-448-2824	920-923-3033	**Fond du Lac**
Forest	715-478-3893	715-478-7796	715-478-4575	715-365-8991	715-762-1346	715-345-7911	715-362-5941 ext 111	**Forest**

APPENDIX C: Contact Information

COUNTY	County Zoning	County Land Conservation Department	DNR Forester	DNR Water Management Specialist	DNR Storm Water Specialist	US Army Corps of Engineers	US Natural Resources Conservation Service	COUNTY
Grant	608-723-2848	608-723-6377	608-723-2397	608-935-1920	608-275-3201	507-895-8059	608-723-6377 ext 130	**Grant**
Green	608-348-9423	608-325-4195	608-325-3050	608-743-4820	608-275-3309	262-547-7869	608-325-4195 ext 101	**Green**
Green Lake	920-294-4026	920-294-4051	608-297-2226	920-787-4686	920-832-1803	715-345-7911	920-294-6140	**Green Lake**
Iowa	608-935-0398	608-935-2791	608-935-1917	908-935-1920	608-275-3201	262-547-7869	608-935-2791	**Iowa**
Iron	715-561-5414	715-561-2234	715-476-3890	715-762-1342	715-685-2926	715-934-2170	715-682-9117 ext 301	**Iron**
Jackson	715-284-0550	715-284-0256	715-284-1417	715-284-1424	715-359-2872	507-895-8059	715-284-4515	**Jackson**
Jefferson	920-674-7130	920-674-7110	608-743-4830	608-743-4820	608-275-3309	262-547-3064	920-674-2020	**Jefferson**
Juneau	608-847-9391	608-847-7221	608-847-9394	715-421-7815	715-359-2872	715-345-7911	608-847-7221	**Juneau**
Kenosha	262-857-1895	262-857-1895	262-884-2390	262-884-2355	262-884-2360	262-547-0868	262-878-1243	**Kenosha**
Kewaunee	920-388-7192	920-845-1360	920-662-5156	920-662-5453	920-662-5441	920-448-2824	920-845-1360	**Kewaunee**
La Crosse	608-785-9722	608-785-9867	608-785-9007	608-785-9010	608-785-9910	507-895-8059	608-782-0180	**La Crosse**
Lafayette	608-776-4830	608-776-3836	608-776-3064	608-935-1920	608-275-3201	262-547-7869	608-776-4028	**Lafayette**
Langlade	715-627-6206	715-627-6292	715-623-4190	715-623-4190 ext 3135	715-762-1346	715-345-7911	715-536-6003	**Langlade**
Lincoln	715-536-0333	715-539-1049	715-536-2152	715-623-4190 ext 3135	715-762-1346	715-345-7911	715-536-6003	**Lincoln**
Manitowoc	920-683-4185	920-683-4183	920-755-4984	920-662-5453	920-662-5441	920-448-2824	920-683-5119	**Manitowoc**
Marathon	715-261-6020	715-261-6000	715-359-5863	715-241-7502	715-359-2872	715-345-7911	715-848-2330	**Marathon**
Marinette	715-732-7535	715-732-7780	715-856-9157	715-582-5041	920-662-5124	920-448-2824	715-735-6122	**Marinette**
Marquette	608-297-9136 ext 259	608-296-2815	608-297-2226	920-787-4686	920-832-1803	715-345-7911	608-296-2815	**Marquette**
Menominee	715-799-5710	715-799-5710	715-799-3405	715-526-4232	920-662-5124	920-448-2824	715-232-2614	**Menominee**
Milwaukee	Call City Hall	414-278-4936	262-594-6209	414-263-8601	414-263-8682	262-547-4171	262-547-3754	**Milwaukee**
Monroe	608-269-8737	608-269-8973	608-269-6901	608-785-9010	608-785-9910	507-895-8059	608-269-8136	**Monroe**
Oconto	920-834-6827	920-834-5688 ext 28	920-846-8103	715-582-5041	920-662-5124	920-448-2824	920-834-5688	**Oconto**
Oneida	715-369-6130	715-369-7835	715-365-2634	715-365-8991	715-762-1346	715-345-7911	715-362-5941 ext 111	**Oneida**
Outagamie	920-832-5255	920-832-5073	920-832-2746	715-526-4232	920-662-5124	920-448-2824	920-733-1575	**Outagamie**
Ozaukee	262-284-8313	262-284-8270	262-670-3404	920-892-8756	414-263-8682	262-547-4171	262-335-4801	**Ozaukee**
Pepin	715-672-8897	715-672-8665 ext 5	715-672-4153	715-684-2914	715-684-2914 ext 123	651-290-5268	715-672-8663	**Pepin**
Pierce	715-273-6747	715-273-6763	715-273-5525	715-684-2914	715-684-2914 ext 123	651-290-5268	715-273-6763	**Pierce**

APPENDIX C: Contact Information

COUNTY	County Zoning	County Land Conservation Department	DNR Forester	DNR Water Management Specialist	DNR Storm Water Specialist	US Army Corps of Engineers	US Natural Resources Conservation Service	COUNTY
Polk	715-485-9279	715-485-8699	715-485-3518	715-822-2702	715-635-4142	651-290-5380	715-485-3138	**Polk**
Portage	715-346-1334	715-346-1334	715-344-2752	715-421-7815	715-359-2872	715-345-7911	715-346-1325	**Portage**
Price	715-339-3272	715-339-2550	715-339-2001	715-762-1344	715-762-1346	715-934-2170	715-748-4121	**Price**
Racine	262-886-8475	262-886-8479	262-884-2390	262-574-2136	262-884-2360	262-547-0868	262-878-1243	**Racine**
Richland	608-647-2447	608-647-2100	608-647-4566	608-275-3228	608-275-3201	507-895-8059	608-647-8874	**Richland**
Rock	608-757-5587	608-754-6617	608-743-4830	608-743-4820	608-275-3309	262-547-3064	608-754-6617	**Rock**
Rusk	715-532-2156	715-532-2162	715-532-4364	715-532-3911	715-762-1346	715-934-2170	715-532-7629	**Rusk**
Saint Croix	715-386-4680	715-684-2874 ext 3	715-684-2914	715-684-2914	715-684-2914 ext 123	651-290-5268	715-684-2874 ext 123	**Saint Croix**
Sauk	608-355-3285	608-355-3245	608-355-4475	608-275-3228	608-275-3279	507-895-8059	608-355-4420	**Sauk**
Sawyer	715-634-8288	715-634-6463	715-634-9658 ext 3504	715-634-9658 ext 3523	715-762-1346	715-934-2170	715-532-7629	**Sawyer**
Shawano	715-526-6766	715-526-6766	715-526-4229	715-526-4232	920-662-5124	920-448-2824	715-524-8520	**Shawano**
Sheboygan	920-459-3060	920-459-1370	920-892-8756 ext 3047	920-892-8756 ext 3031	414-263-8682	262-547-4171	920-467-9917	**Sheboygan**
Taylor	715-748-1485	715-748-1469	715-748-4955	715-532-3911	715-762-1346	715-934-2170	715-748-4121	**Taylor**
Trempealeau	715-538-2311 ext 223	715-538-2311	715-538-4480	715-284-1424	608-785-9910	507-895-8059	715-538-4396	**Trempealeau**
Vernon	608-637-5271	608-637-5480	608-637-3784	608-785-9010	608-785-9910	507-895-8059	608-637-8321	**Vernon**
Vilas	715-479-3620	715-479-3747	715-385-3355	715-358-9214	715-762-1346	715-345-7911	715-362-5941 ext 111	**Vilas**
Walworth	262-741-4972	262-741-4972	262-594-6209	262-574-2136	262-574-2126	262-547-3064	262-723-3216	**Walworth**
Washburn	715-468-4690	715-468-4654	715-635-4084	715-635-4097	715-635-4142	715-934-2170	715-635-8228	**Washburn**
Washington	262-335-4445	262-335-4800	262-594-6209	414-263-8701	262-574-2129	262-547-4171	262-335-4801	**Washington**
Waukesha	262-548-7790	262-896-8300	262-594-6209	262-574-2137	262-574-2126	262-547-0868	262-547-3754	**Waukesha**
Waupaca	715-258-6255	715-258-6245	715-258-8432	715-526-4232	920-832-1803	715-345-7911	715-258-8380	**Waupaca**
Waushara	920-787-0453 ext 227	920-787-0443	920-787-4686	920-787-4686 ext 3016	920-832-1803	715-345-7911	608-296-2815	**Waushara**
Winnebago	920-448-5142	920-232-1950	920-424-3056	920-424-7885	920-832-1803	920-448-2824	920-424-0329	**Winnebago**
Wood	715-421-8466	715-421-8475	715-421-7839	715-421-7815	715-359-2872	715-345-7911	715-423-3610	**Wood**



Tall fescue, an invasive grass to avoid in seed mixes.

Photo by Elizabeth J. Czarapata

APPENDIX

D

Seed Mix Information

Seed mixes are used to revegetate areas of bare soil. Seeding will allow plants to become quickly established on these sites, minimizing erosion; however, care must be taken to select appropriate plant species for your site. Many times a seed mix will include both a short-lived cover crop, like oats, that will quickly occupy disturbed sites and act as a nurse crop while long-lived species become established.

Native Grasses

The following list contains grass species that are native to Wisconsin. More detailed information on plant species, seed mixes, and seeding rates can be found in *Wisconsin's Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners and Loggers*, Appendix H: Species Recommended for Revegetation.

Table D-1. Native Grass Species Recommended for Seed Mixes

GRASS SPECIES		SITE CHARACTERISTICS					
Common Name	Scientific Name	Dry	Dry-Mesic	Mesic	Wet	Shady	Sunny
Big Bluestem	*Andropogon gerardii*	•	•	•			•
Fringed Brome	*Bromus ciliatus*			•	•	•	
Kalm's Brome	*Bromus kalmii*		•	•			•
Bluejoint Grass	*Calamagrostis canadensis*			•	•		•
Broom Sedge	*Carex scoparia*			•	•	•	
Fox Sedge	*Carex stipata*			•	•		•
Tussock Sedge	*Carex stricta*			•	•	•	•
Brown Fox Sedge	*Carex vulpinoidea*			•	•		•
Canada Wild Rye	*Elymus canadensis*		•	•	•		•
Bottlebrush Grass	*Elymus hystrix*	•	•	•		•	
Virginia Wild Rye	*Elymus vinginicus*		•	•	•		•
Reed Manna Grass	*Glyseria grandis*			•	•		•
Dudley's Rush	*Juncus dudleyi*			•	•	•	
Common Rush	*Juncus effuses*				•		•
June Grass	*Koeleria macrantha*	•	•				•
Switch Grass	*Panicum virgatum*	•	•	•	•		•
Little Bluestem	*Schizachyrium scoparium*	•	•				•
Dark Green Bulrush	*Scirpus atrovirens*			•	•		•
Wool Grass	*Scirpus cyperinus*			•	•		•
Indian Grass	*Sorghastrum nutans*	•	•	•			•
Needle Grass	*Stipa spartea*	•	•			•	•

Non-Native Cover Crops

The non-native species listed below are suitable for cover crops and will provide short term erosion control until other plant species become established. This is not a complete list.

Table D-2. Non-Native Species Recommended for Seed Mixes

SPECIES		SITE CHARACTERISTICS					
Common Name	Scientific Name	Dry	Dry-Mesic	Mesic	Wet	Shady	Sunny
Oats	*Avena sativa*	•	•	•			•
Red Fescue	*Festuca rubra*		•	•			•
Barley	*Hordeum vulgare*		•	•			•
Alsike Clover	*Trifolium hybridum*		•	•			•
Red Clover	*Trifolium pratense*		•	•	•	•	•
White Clover	*Trifolium repens*		•	•		•	•

Invasive Species to Avoid

The following list contains species that had been previously recommended for use in seed mixes, but have since been found to be invasive. These species should **NOT** be used in seed mixes.

Table D-3. Invasive Species NOT Recommended for Seed Mixes

Common Name	Scientific Name
Creeping Bent Grass	*Agrostis palustris*
Smooth Brome Grass	*Bromus inermis*
Crown Vetch	*Coronilla varia*
Quack Grass	*Elytrigia repens*
Tall Fescue	*Festuca arundinacea*
Flat Pea	*Lathyrus sylvestris*
Chinese Lespedeza	*Lespedeza cuneata*
Bird's Foot Trefoil	*Lotus corniculatus*
Big Leaf Lupine	*Lupinus polyphyllus*
Reed Canary Grass	*Phalaris arundinacea*

Seed mixes should include fast growing species for quick soil protection and perennial species for permanent cover. Recommendations for seed mixes suited to your region are available from your local Wisconsin DNR wildlife management specialist, county land conservation department and NRCS office. Many native seed companies and local farm cooperatives also offer seed mixes that may be appropriate to your site.

Elizabeth J. Czarapata

ABOVE: Crown vetch

Elizabeth J. Czarapata

ABOVE: Reed canary grass

RESOURCES

Native Plant Nurseries and Restoration Consultants in Wisconsin

- Lists companies that carry native seeds and plants
- http://www.dnr.wi.gov/org/land/er/plants/nurseries.htm

Wisconsin's Forestry Best Management Practices for Invasive Species: A Field Manual for Foresters, Landowners and Loggers

- Offers information on revegetating sites and detailed native species lists
- http://council.wisconsinforestry.org/invasives/forestry.php

Erosion control netting.

American Excelsior Company

APPENDIX

E

Erosion and Sediment Control Products

This appendix provides a brief description of several common types of erosion and sediment controls. The list includes the product names and manufacturers. Local providers of these products include landscape suppliers, farm cooperatives, and other companies. This list is based on information provided in WisDOT's Erosion Control Product Acceptability Lists for Multi-Modal Applications, available at: http://www.dot.wisconsin.gov/business/engrserv/docs/pal.pdf. This listing is not intended as an endorsement of these companies.

Light Duty Erosion Mats (Class I)

American Excelsior Company

ABOVE: Close-up of Curlex II

Erosion mats are manufactured blankets or mats available in rolls or strips. The light duty mats are for short duration projects (6 months or greater). They are comprised of organic materials bound together with netting. The netting may be non-organic, photodegradable, or biodegradable. Plastic netting is not recommended in areas where there is a high probability of entrapping animals (See Table E-2).

Products with a UV degradable netting should not be installed after September 1st because of poor performance through the winter and spring months until vegetation is established. Other appropriate products will need to be installed if working after September 1st.

The listings below are not complete and other products may also qualify as light duty erosion mats.

Table E-1. Light Duty Erosion Control Mats

Products	Manufacturer
Curlex I WH, Curlex I, Curlex II, Curlex LT	American Excelsior
S31, S31UVD, S32	Erosion Control Blanket.com
S75, DS75, S150, DS150, SC150	North American Green
Landlok S1, Landlok CS2, Landlok S2	Propex
Winters Straw SNW, Winters Straw SNG	Winters Excelsior

Steve Toman

Table E-2 contains a listing of light duty erosion mats that are appropriate in environmentally sensitive areas where animals may become entrapped in plastic netting.

LEFT: Young trout trapped in erosion control netting

Table E-2. Light Duty Erosion Control Mats for Environmentally Sensitive Areas

Products	Manufacturer
Curlex I Fibrenet, Curlex II Fibrenet, Curlex NetFree	American Excelsior
S75 BN, S150 BN, SC150 BN	North American Green
Winters Straw Bio, EXCEL SS-2 All Natural	Winters Excelsior

Medium Duty Erosion Mats (Class II)

Medium duty erosion mats have the same characteristics mentioned above, but are intended for long term use (3 years or greater). The listing below is not complete and other products may also qualify as medium duty erosion mats.

Table E-3. Medium Duty Erosion Control Mats

Products	Manufacturer
AEC Premier Coconut	American Excelsior
C32	Erosion Control Blanket.com
C125, C125 BN, C350	North American Green
Winters Coir HV	Winters Excelsior

Table E-4 contains a listing of medium duty erosion mats that are appropriate in environmentally sensitive areas where animals may become entrapped in plastic netting.

Table E-4. Medium Duty Erosion Control Mats for Environmentally Sensitive Areas

Products	Manufacturer
Dekowe 700, Dekowe 900	Belton Industries
Bio D-Mat 70	RoLanka

Temporary Ditch Checks

Temporary ditch checks can be as simple as straw bales, but other products are also available. They are intended for use at the bottom of slopes and in channels to intercept and pond sediment-laden runoff. Ponding slows runoff and allows some of the sediment to settle out. Water exits the ditch check by filtering through it or by flowing over the top of it.

Temporary ditch checks should be placed perpendicular to the flow line of the ditch and should extend far enough so that the ground level at the ends of the check are higher than the low point on the crest of the check. Log-type ditch checks should be installed similar to straw bales. All ditch checks should be trenched in a minimum of 2 inches on bare soil.

Table E-5. Temporary Ditch Checks

Products	Manufacturer
Curlex 12-inch Sediment Log, Curlex 20-inch Sediment Log, AEC Premier 12-inch Wattle	American Excelsior
Stenlog 12	Erosion Control Blanket.com
Triangular Silt Dike	Triangular Silt Dike
Aspen Xcel Excelsior Log	Western Excelsior
Ditch Chexx	Filtrexx
Bio-D Silt Check	RoLanka
WS-12	North American Green

Erosioncontrolblanket.com

ABOVE: Temporary ditch check with sediment log

Using geotextiles in wetland roads can help preserve water flow through wetlands.

Carmen Wagner, DNR

APPENDIX

F

Geotextile Fabrics

Joe Arington

ABOVE: Construction of a permanent wetland road with geotextile

Geotextile fabrics serve three primary functions on unpaved roads. First, they provide separation. Without them, gravel and roadbed materials mix. Mixing reduces the load bearing capacity of the road and leads to rutting. Geotextiles allow water to pass through the materials, while preventing mixing of the layers.

Geotextiles also provide filtration and increased drainage capacity on wet or saturated soils. When heavy equipment drives over a wet road, the pressure causes a slurry to press up against the fabric. The fabric acts a filter, allowing water to flow upward, but screening out fine soil materials. This prevents mixing of the layers and allows water to freely drain. Water can pass through the fabric, but soil and gravel cannot. Water in the road can then evaporate, preventing water pockets from forming.

Geotextiles also allow rapid water drainage in wet roads. Providing drainage is critical to maintaining structural stability of roads.

The benefits of using geotextile fabrics include:

- reduced maintenance costs
- less gravel needed to carry expected loads
- reduced initial construction costs
- longer lasting road surfaces

Types of Geotextiles

Geotextiles are available as woven and non-woven fabrics. Woven can withstand higher stress and strain than non-woven. However, woven fabrics have lower abrasion resistance, less permeability, and poorer surface structure friction than non-woven.

Non-woven fabrics allow water to pass through them and are recommended for most unpaved roads. They offer superior resistance to abrasion and provide filtration and drainage. Under load, they develop high tensile strength and have good friction properties. These characteristics combine to make them a good choice for reinforcement.

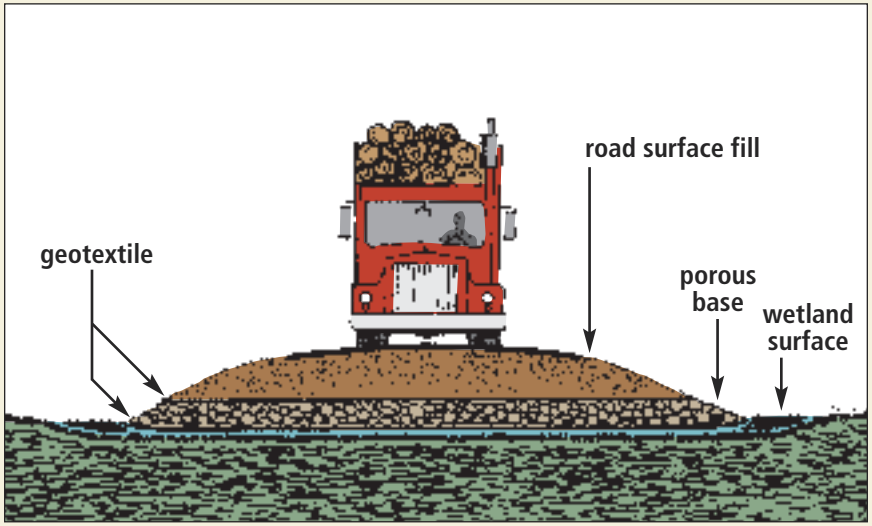
Using Geotextiles

Clear and grade the area. Remove any sharp objects. Cut tree stumps and shrubs flush with the subgrade. It is unnecessary to remove top soil and non-woody vegetation. Excavate soft spots, backfill, and compact, so that filled sections provide equal stability as adjacent areas. Grade the surface and cross slope shape to provide good drainage. Tight blading provides a smooth surface to support the fabric and a well-established crown.

Unroll the fabric in the direction of the construction traffic. Overlap in the direction of the roadbed placement. Overlap width depends on the load bearing capacity of the roadbed, but varies from two to three feet.

Dump the gravel on top of the fabric. Spread with a small loader. Avoid heavy traffic directly on the fabric. Spread the gravel in the same direction as the geotextile. Overlap to avoid separation. Gravel depth is determined by the roadbed strength and anticipated weight loads. It usually varies from four to six inches. Compact the gravel using a roller. Vibratory compaction is not recommended.

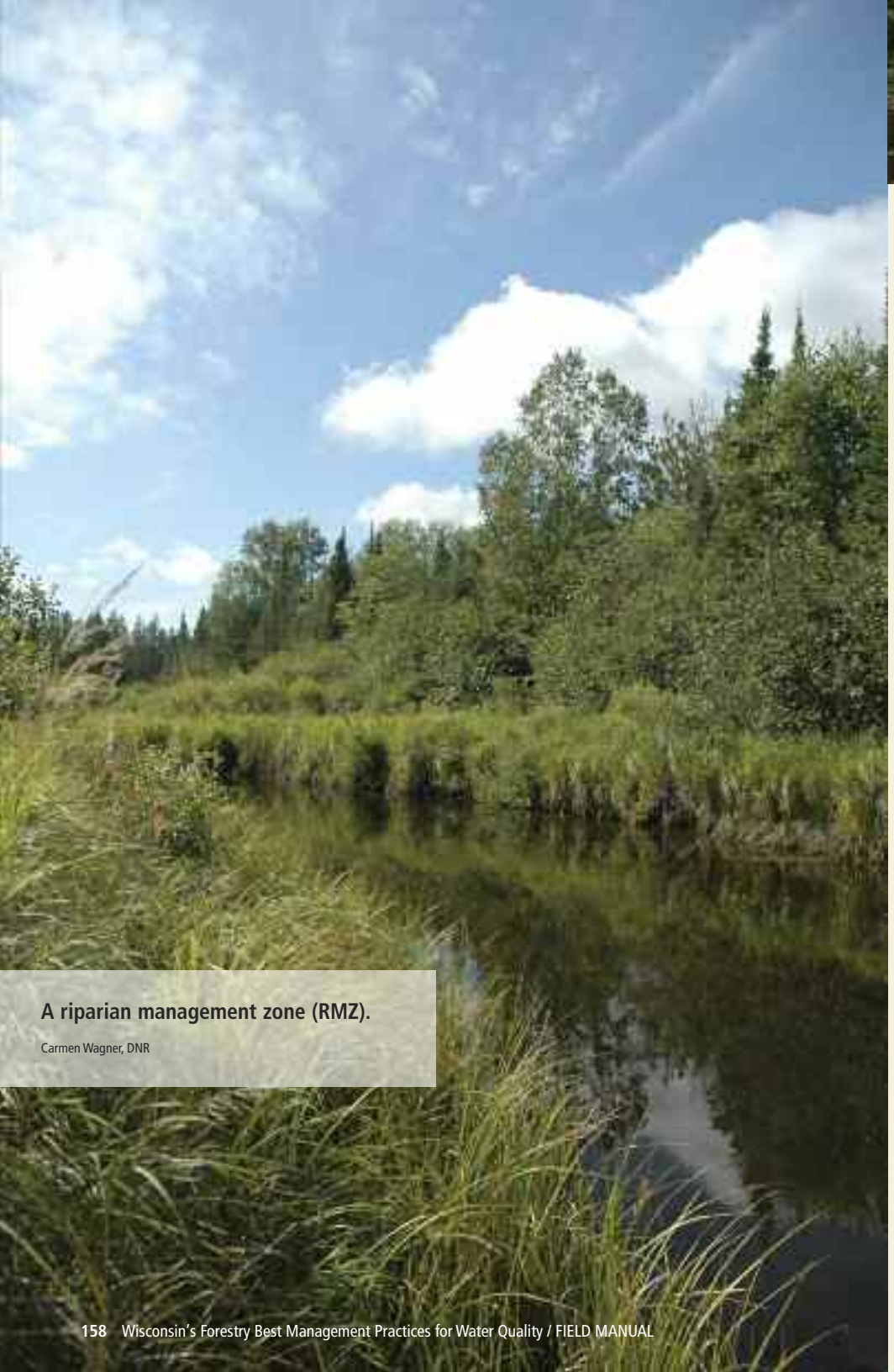
Road Construction with Geotextile



Additional Considerations

Proper installation of geotextile fabric is essential to stabilize a road. The gravel must be placed to its full depth and applied carefully as to not cause damage to the fabric by equipment.

Wrinkled or torn fabrics will not perform well. Repair fabric damage during installation. Clear the damaged area plus an additional three feet of gravel around the damage. Cover the area with a geotextile patch extending three feet beyond the damage. Replace the gravel and compact.



A riparian management zone (RMZ).

Carmen Wagner, DNR

APPENDIX G

Glossary

Basal area: The cross-sectional area 4½ feet above ground expressed in square feet per acre of all trees with a diameter of 5 inches and larger.

Best management practices (BMPs): Practical and economically achievable practices for preventing or reducing nonpoint source pollution.

Broad-based dip: A surface drainage structure specifically designed to drain water from an access road while vehicles maintain normal travel speeds.

Channelized runoff: Concentrated surface water flow that is causing erosion.

Contour: An imaginary line on the surface of the earth connecting points of the same elevation or a line drawn on a map connecting the points of the same elevation. The steeper the slope, the closer the contour lines will be.

Crown: A convex road surface that allows runoff to drain to either side of the road prism.

Culvert: A metal, wooden, plastic, or concrete conduit through which surface water can flow under roads.

Cut and fill: Earth-moving process that entails excavating part of an area and using the excavated material for adjacent embankments or fill areas.

DBH: Diameter at breast height; the average diameter (outside the bark) of a tree 4½ feet above mean ground level.

Disking (harrowing): A mechanical method of scarifying the soil to reduce competing vegetation and to prepare a site to be seeded or planted.

Drainage structure: Any device or landform constructed to intercept and/or aid surface water drainage.

Dry wash: An erosion feature that is an incised, v-shaped gully on a hillside that generally only receives water flow as surface runoff from spring snowmelt and rainstorms.

Duff: The accumulation of needles, leaves, and decaying matter on the forest floor.

Erosion: The process by which the surface of the earth is worn away by the action of wind or water.

Erosion prone sites: Soils that are likely to have high soil loss when exposed to water runoff. Soils having a Natural Resources Conservation Service (NRCS) erosion hazard rating of "moderate" or "severe" should be considered erodible. Erosion hazard ratings for different soil types are listed in the "Woodland Suitability" tables in the NRCS soil surveys. Generally, forest soils occurring on 15 to 35% slopes have a moderate rating and soils occurring on greater than 35% slopes have a severe rating.

Felling: The process of cutting down standing trees.

Filter strip: A strip of land located adjacent to wetlands that trap sediment and other pollutants from runoff before it reaches the wetlands.

Fine woody material: Woody material, living or dead, less than 4 inches diameter inside bark at the large end; including fine woody debris and portions of standing living and dead shrubs and trees.

Firebreak: Naturally occurring or human-made barrier to the spread of fire.

Fireline: A barrier used to stop the spread of fire constructed by removing fuel or rendering fuel inflammable by use of fire retardants.

Fire retardant: Any substance except plan water that by chemical or physical action reduces flammability of fuels or slows their combustion rate.

Floodplain: Land which has been or may be covered by flood water during the regional flood (floods expected to occur once every 100 years).

Ford: Submerged stream crossing where the streambed may need to be reinforced to bear intended traffic.

Forest road: A temporary or permanent road connecting the most remote part of the forest land to existing public roads.

Grade (gradient): The slope of the road or trail expressed as a percentage of change in elevation per unit of distance travelled.

Harvesting: The felling, skidding, processing, loading, and transporting of forest products.

Lake: A waterbody that (1) is navigable, (2) has an ordinary high water mark, and (3) has a defined bed and banks and is a "reasonably permanent" body of water, although it may dry up during periods of drought.

Landing (log deck): a place in or near the forest where logs are gathered for further processing or transport.

Mulch: A natural or artificial layer of plant residue or other materials covering the land surface that conserves moisture, holds the soil in place, aids in establishing plant cover, and minimizes temperature fluctuations.

Navigable: A waterway that has a defined bed and banks, and is capable of floating a canoe or other small craft on a regularly reoccurring basis – even if only during spring runoff.

Nonpoint source pollution: Occurs when rainfall or snowmelt moves across the ground, carrying pollutants into lakes, streams, wetlands and groundwater. For example, soil can become a pollutant when runoff moves across a road and carries large amounts of soil into a waterbody.

Ordinary high water mark (OHWM): The point on the bank or shore up to which the presence and action of water is so continuous as to leave a distinct mark either by erosion, destruction of terrestrial vegetation, or other easily recognized characteristics.

Out-slope: A road surface shape that causes drainage to flow towards the outside shoulder.

Prescribed burning: Skillful application of fire to natural fuels that allows confinement of the fire to a pre-determined area and at the same time produces certain planned benefits.

Raking: A mechanical method of removing, stumps, roots, and slash from a future planting site.

Regeneration: The process of replacing older trees removed by harvest or disaster with young trees.

Riparian management zone (RMZ): Areas next to lakes, streams and dry washes where management practices are modified to protect water quality, fish habitat and other aquatic resources. These areas are complex ecosystems that provide food, habitat and movement corridors for both aquatic (water) and terrestrial (land) communities as well as help to minimize nonpoint source pollution to surface water.

Riprap: Rock or other large aggregate that is placed to protect streambanks, bridge abutments, outflows of drainage structures, or other erodible sites from runoff or wave action.

Rut: A depression made by the passage of a vehicle or equipment.

Scarification: The process of removing the forest floor or mixing it with the mineral soil by mechanical action preparatory to natural or direct seeding or the planting of tree seedlings.

Sediment: Soil that has eroded from the land surface, often by overland water action, and is then transported and deposited away from its original location.

Shearing: A site preparation method that involves the cutting of brush, trees, and other vegetation at ground level using tractors equipped with angled or V-shaped cutting blades.

Silt fence: A temporary barrier used to intercept sediment-laden runoff from small areas.

Site preparation: A silvicultural activity to remove unwanted vegetation and other materials, and to cultivate or prepare the soil for regeneration.

Skid trail: A temporary, non-structural travel way for logging equipment, called skidders, to drag felled trees or logs to the landing for further processing, loading and transport to a mill.

Slash: Any tree tops, limbs, bark, abandoned forest products, windfalls, or other debris left on the land after timber or other forest products have been cut.

Stream: A watercourse that (1) has an ordinary high water mark, (2) has a defined bed and banks, (3) flows at least periodically, and (4) does not lose its character as a water course even though it may become braided in a wetland complex.

Water bar: A shallow trench or diversion dam which diverts roadside ditch and surface water runoff from roads (inactive or closed), firebreaks, or skid trails (active or inactive) into a dispersion area. Water bars are used to minimize erosion.

Wetland: An area where water is at, near or above the land surface long enough to be capable of supporting aquatic or hydrophytic (water loving) vegetation and has soils indicative of wet conditions.

2010 Forestry BMPs for Water Quality Advisory Committee

Organizations	Members
1000 Friends of Wisconsin	Ken Adamovich
FISTA	Aaron Caylor
Great Lakes Timber Professionals Association	Matt Dallman
Lake States Lumber Association	John DuPlissis
The Nature Conservancy	Gary Edinger
Packaging Corporation of America	Mike Gehrke
River Alliance of Wisconsin	Earl Gustafson
SFI SIC	Theresa Heyer
Society of American Foresters	Steve Kariainen
NewPage Corporation	Kent Mikkelson
Thilmany Procurement Group	Bill O'Brion
Trout Unlimited	Bob Obma
USDA Forest Service	Jim Olive
University of Wisconsin–Stevens Point	Dean Pelkey
Wisconsin Association of Lakes	Bob Rogers
Wisconsin Council on Forestry	Jane Severt
Wisconsin County Forests Association	Tim Tollefson
Wisconsin DNR, Division of Water	
Wisconsin Paper Council	
Wisconsin Wetlands Association	
Wisconsin Woodland Owners Association	