Cover Page

New Hampshire Best Management Practices for Erosion Control on Timber Harvesting Operations

DRAFT

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ACKNOWLEDGEMENTS

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1. Introduction

New Hampshire is the second-most forested state in the country, with forests covering approximately 84% of the state. These forests play an important role in the water cycle, contributing to the high quality of water found in New Hampshire's lakes, streams and wetlands. The term "water quality" is more than water clarity. Water quality encompasses the chemical, physical, and biological properties of water in lakes, streams and wetlands.

The purpose of this publication is to serve as a reference to help foresters and loggers become better informed about the best management practices for reducing soil erosion and controlling sedimentation before, during and after timber harvesting operations. When using this publication, it is important to remember that for every situation encountered, there may be more than one correct method to prevent or minimize erosion and sedimentation.

What This Handbook Is

This handbook describes Best Management Practices, or BMPs, for protecting water quality during forest harvests. The BMPs include a wide range of recommended techniques that can be used before, during, and after logging operations. Loggers, foresters, and scientists from New Hampshire and other states have developed these techniques from their own practical experience and research.

This handbook is for woodlot owners, loggers, foresters, and others involved in harvest operations. The handbook will help you understand, identify, design, and implement water quality protection measures while meeting other harvest objectives.

This book will help you to:

- understand how BMPs work. It is more effective, cheaper, and easier to prevent pollution than to fix problems after they occur. When you understand the principles behind BMP techniques, you will be able to anticipate and prevent problems before they end up costing you time and money.
- decide which BMPs to use. Harvest sites can vary significantly, and different techniques are appropriate to different sites. By applying BMP principles, you will be able to use your own judgment and this handbook to select the most appropriate and effective BMPs for a particular site.

What This Handbook Is Not

BMPs may not be the same as regulations. Best Management Practices are procedures that, when used appropriately, will result in the greatest protection of the environment over the course of the operation.

Regulations describe required, minimally acceptable practices. BMPs are mandatory in some situations; others may be voluntary, depending on the site. If the forestry management or harvesting activities involve impacts to wetlands or surface waters (by traveling across them), BMPs are mandatory and a NH DES Forestry Notification may be required.

This handbook focuses on water quality BMPs. There are BMPs that protect wildlife habitat, soil integrity and productivity, aesthetics, and other aspects of the forests. Although these values are important, they are not the primary focus of this manual.

How to Use This Handbook

The BMP manual is most effective when used as a resource for planning a timber harvest. It provides information about

why water quality is important and how to protect it. In addition, the BMP manual provides tips and techniques that assist land managers with low-cost and effective methods for protecting water quality while constructing roads, landings, skid trails and stream and wetland crossings. If you are new to BMPs, it is best to read the publication all the way through to get a sense of the content, layout, glossary and other resources available.

2. HOW TIMBER HARVESTING AFFECTS WATER QUALITY

Timber harvests can directly impact water quality by affecting how water flows through an area. In particular, constructing roads, trails, landings, or drainage systems can:

• **reduce the soil's infiltration capacity.**
This can occur any time the forest floor is disturbed, removed, compacted, or otherwise damaged.

• **increase potential soil erosion.**
The opportunity for soil to be carried away by runoff increases greatly when mineral soil is exposed or fill is used.

• **divert water flows.**
Roads and trails can block or intercept water moving over or through the soil. The more water that accumulates, the greater the chance that it will form a channel and start eroding soil. Sometimes harvesting can cause streams to erode a new channel by blocking the stream's flow with logs or debris.

• **concentrate water flows.**
Roads, trails, landings, and their associated drainage structures can collect and funnel runoff, creating rills or gullies. In these situations, water erodes and transports exposed soil in its path.

• **diminish the benefits of vegetation next to waterbodies.**
Harvesting may reduce shade on the water's surface, reduce the amount of natural woody debris, or eliminate leaf litter that is an important food source for aquatic life. In addition, timber harvests that remove a significant percentage of the trees in a watershed can increase the amount of water moving

through the soil into streams, and in some instances, increase flooding.

Drawing of water movement
Pg 10, 2005 document

3. How BMPs Protect Water Quality

A. Control Water Flow

- Plan how water moves within and around the harvest area and decide how water flow will be controlled.

- Concentrated flows of water on roads, skid trails, landings, and in drainage systems develop more force and a greater ability to erode soil and carry sediment.

- Control small volumes of water before they converge and accumulate into concentrated flows.

- Slow down runoff and spread it out. Many BMPs work by directing small amounts of water into areas of undisturbed forest floor where it can be absorbed.

B. Minimize and stabilize exposed soil

- Limit soil disturbance and stabilize areas where mineral soil is exposed. These practices are most critical in and around riparian management zones —forest areas bordering water bodies.

- Protect exposed soil, which can erode very rapidly. Most of the sediment that ends up in streams near managed forests comes from exposed soil on roads, landings, and skid trails.

- Know where the riparian management zones are and how to protect their capacity to absorb and filter runoff

- Stabilize areas of exposed soil, within riparian management zones and in other locations where runoff has the potential to reach water body or wetland.

- Using BMPs during or immediately after the harvest prevents exposed soil or fill from eroding.

C. Protect the integrity of water bodies

- Protect stream channels and banks. Blocking or altering streams (with slash, for instance) may keep fish from swimming past the blockage. Damaged stream banks erode quickly causing sedimentation and siltation. By protecting the physical integrity of streams, BMPs prevent fish passage issues.

- Leave enough shoreland vegetation to maintain water quality. BMPs maintain the benefits that nearby trees and plants provide water bodies. Stream side vegetation shades the water, minimizing temperature changes. Live roots stabilize the banks and maintain the soil's physical and chemical properties. Trees, along the banks, drop leaf litter and woody debris that supply nutrients and provide some habitat for plants and animals in the stream. Shoreland vegetation plays and important role in maintaining water quality.

Stop Box:

> Installation of large woody debris for habitat management requires a permit from the NH Department of Environmental Services. Contact DES at 603-271-2214 or visit www.des.nh.gov for more information.

D. Handle hazardous materials safely

- Be prepared for any emergency. Keep an emergency response kit and contact information at the site for fuel, oil, or chemical spills. Remember that fertilizers, herbicides, pesticides, and road chemicals (calcium chloride and road salt) are hazardous materials too.

- Use and store hazardous materials properly. The best way to avoid accidental spills of hazardous materials is to store and handle them so that the chance of these types of emergencies occurring is minimized. You'll find several BMPs in this manual that describe how to do this starting on page XX

- Help to prevent equipment and forest fires by reducing the amount of debris that builds up on and around machinery. Careful use of smoking materials around machinery and in the woods can help to prevent accidental fires. Make sure each piece of machinery has a working fire extinguisher on board.

4. Planning

The most important consideration in implementing a good timber harvest is planning. Planning will help reduce costs, make the job more efficient, protect roads and trails, leave the job looking better, as well as protect water quality. Part of planning is considering which Best Management Practices (BMPs) will be used on the site to stabilize soil and protect water quality. Planning should include the following:

Drawing of landowner & other walking in woods
GFGS pg 69 or pg 23

Determine landowner objectives

- Communicate, with everyone involved, throughout the operation to avoid problems.
- Make sure objectives are clearly spelled out in the written contract including who is responsible for the BMPs.

Evaluate the property

- Establish boundaries and identify access to the property
- Obtain topographic maps, soil maps and aerial photographs
- Walk the property and lay out harvest operation
- Identify location of streams, ponds, wetlands, vernal pools and other sensitive areas
- Identify areas where BMPs are needed
- Evaluate timing of the logging operation—what time of year etc.
- Flag landings, skid trails, stream/wetland crossings and drainage features
- Find out what legal requirements and permits (or notifications) apply to operating around lakes, ponds, streams and wetlands in the harvest area

Fundamental Best Management Practices (BMPs)

- Choose BMPs that are appropriate to the site conditions (see page XX for specific techniques)
- Consider weather conditions such as rainstorms and spring break up.
- Determine how water will move throughout the area.
- Decide on BMPs for the entire harvest area before beginning work
- Plan to monitor, maintain, and adjust BMPs as needed to deal with seasonal or unpredictable, weather-related changes

5. New Hampshire's Water Resources

New Hampshire has hundreds of lakes and ponds, large areas of forested and non-forested wetland, and thousands of miles of streams and rivers. All these forest waterbodies, and the areas that drain to them, are connected by moving water.

WATERSHED

A **watershed** is all the land and waterbodies from which water drains to a given point. You can define a watershed for an entire lake, for a stream at a crossing site, or for a river where it reaches the ocean. Watersheds range in size from just a few acres (for a small stream), to thousands of acres (for a large river). All land is part of some watershed.

It is crucial to understand where water is coming from and draining to in the watershed where logging is planned. The amount of cutting or road construction at higher elevations can affect the amount and timing of runoff at lower elevations within the same watershed. When you know where, when, and how much water flows in the harvest area, you will be able to determine the best locations for roads and trails, the size of any crossing and what types of BMPs you will need to control water movement.

Watershed diagram

In this manual, "waterbodies" includes streams, rivers, lakes, ponds, and wetlands, as well as coastal areas. These BMPs are primarily for those areas where water is at or near the surface (streams, lakes, or wetlands), and where runoff can move directly into surface waterbodies. These waterbodies and related areas are defined and illustrated below.

EPHEMERAL FLOW AREAS

Ephemeral flow areas are small drainage areas that flow into streams, but have no defined, continuous channel. Examples are low-lying depressions, or swales with an intact forest floor. Soils in these areas may quickly become saturated during rainy periods, storms, or snowmelt. Surface water flows in these low areas over saturated soil without forming a channel. Water from ephemeral flow areas may carry sediment or other materials directly into streams. Ephemeral flow areas change in size in response to the soil and weather conditions, and are the proximate source of much of the water that enters small streams. Many ephemeral flow areas are wetlands

STREAMS

Streams are natural water channels that:

- may flow year-round or only part of the year,
- have a defined channel and banks,
- are relatively continuous and connected with larger surface waters, and
- have a streambed where flowing water has exposed the mineral bottom of soil, sand, gravel, ledge, or rock.

Forest streams in New Hampshire vary widely in how much water they carry, how steep they are, the shape of the streambed or channel, how much area they drain, and when they flow.

Perennial streams

- generally flow year-round
- range from small brooks to large rivers

Intermittent streams

- flow only a few months of the year, or during wet seasons.

The **normal high water mark** is the place on the stream bank where the highest water levels typically occur, often during spring runoff. You can identify it from features like undercutting of the bank; a change in the type of vegetation; exposed roots that do not penetrate beyond a certain level; root scars; and water stains on rocks, stems, roots, or other vegetation.

WETLANDS

Wetlands are areas where soils are saturated or flooded at least part of the year, and where water-loving plants are often found. Wetland soils usually have developed special characteristics, and have water at or near the surface.

Forested wetlands are dominated (or potentially dominated) by trees taller than 20 feet. Forested wetlands vary widely in their characteristics, often have relatively little water directly at the surface, and have indistinct borders. They may require considerable expertise to identify. Forested wetlands are often managed for timber, with roads and trails crossing them.

Bogs (non-forested or **open wetlands)** are not dominated by trees, though they may have some scattered trees, mostly less than 20 feet tall. They have water at or near the surface at least part of the year, and may have a more or less distinct border defined by the surrounding forest. The high water and organic content of wetland soils make them considerably weaker than upland soils and difficult to work in. The NHDES Forestry Notification form cannot be used to cross a bog (or marsh). Contact NHDES for permitting information.

Vernal pools are a type of wetland, typically forested, which provide specialized habitat for amphibians and reptiles and deserve special attention. They are small, seasonal wetlands that lack and inlet and outlet and lack

fish populations. During the dry seasons they may only be recognizable as an isolated depression in the forest floor. A wide variety of other wildlife species also use vernal pool habitats, including several threatened and endangered species.

Separate guidelines for identifying vernal pool habitat are available from the NH Fish & Game Department, Non-game and Endangered Species Program. Further information regarding recommended practices for timber harvesting near vernal pools can be found in section 7.3 of *Good Forestry in the Granite State: Recommended Voluntary Forest Management Practices for New Hampshire*, 2010.

Wetlands Characteristics:

Hydrology, or the presence of water in or above the soil;
Signs on the surface of the ground include:

- Water stained (dark) or silt covered leaves;
- Lines of organic debris such as leaf litter on tree and shrub stems above soil surface;
- Water or silt stained plant stems;
- Swollen bases of tree trunks (an adaptation to wet soils);
- Exposed plant roots (an adaptation to wet soils).

Soils, which show observable features when saturated or flooded for long periods of time;
Signs in the soil include:

- Sphagnum moss on the surface;
- A thick upper layer of peaty organic matter;
- Soils mostly neutral grey in color (greyed), or grey soils with rust colored (orange-brown and yellow-brown) splotches within 18" of the surface.

Vegetation, which is usually composed of a predominance of species suited to hydric (largely anaerobic) soil habitats.

Signs in the composition of plant species include:

- More than half the plant species being those that grow most often in wetland soils. Plant species have been classified by the US Fish & Wildlife Service based on how frequently they occur in wetlands. All plants, including herbaceous groundcovers, are important in wetland determination. However, only trees and shrubs are included here because there are fewer species than herbaceous plants, they are more easily identified by most people and they can be observed and identified at all times of the year. The species are grouped into five categories, listed here from most to least wetland adapted:

Obligate Wetland

Species occur more than 99% of the time in wetlands.

Facultative Wetland

Species occur between 67-99% of the time in wetlands.

Facultative

Species occur equally in uplands and wetlands.

Facultative Upland

Species occur between 1-33% of the time in wetlands.

Obligate Upland

Species occur less than 99% of the time in wetlands.

See **Appendix A** for the frequency of occurrence of selected NH tree and shrub species in wetlands and uplands.

6. Riparian Management Zones

Riparian management Zones – are areas next to lakes and streams where timber harvesting practices are modified to protect water quality, fish habitat, and other aquatic resources.

Riparian management zones help to:

- Filter sediment and nutrition from runoff;
- Allow water to soak into the ground;
- Stabilize lakeshores and streambanks
- Shade streams; and
- Provide food and habitat for aquatic organisms.

Riparian management zones have several components:

- The banks of the stream (or other waterbodies) protect and contain the water channel
- The undisturbed forest floor – especially the leaf litter, woody debris, and organic soil layer – absorbs and filters water as it moves over and through the soil.
- Trees and other vegetation shade the water (minimizing changes in water temperature), stabilize the banks, and add woody debris and organic matter to the water and forest floor.

Limiting impacts to these components within a minimum distance from the waterbody (depending on slope) typically maintains these benefits and protects water quality.

Determine what legal requirements you must meet when working near water bodies.

Delineate riparian management zones next to streams, lakes and ponds, and wetlands. Minimum

recommended widths (from the normal high water mark or edge of wetland) for riparian management zones appear in Table 1

Apply BMP techniques for roads, landings and skid trails (described in later sections) when working in riparian management zones to:

• minimize damage to the stream channel, stream banks and wetlands;
• protect the forest floor next to streams and other waterbodies from disturbance;
• disperse concentrated flows of water through the area;
• minimize or stabilize exposed soil; and
• retain an adequate canopy of trees and/or other vegetation.

Increase the width of the riparian management zone and install more BMPs when local conditions call for it. The recommended minimum riparian management zones widths are based on the ability of the undisturbed forest floor to absorb water and filter sediment. The actual width needed for the riparian management zone to be effective may be greater than the minimums listed in Table 1, depending on the site conditions and planned activity. Examples of situations where it is best to designate a riparian management zone wider than that stated in Table 1 include:

- **ephemeral flow areas next to waterbodies**. Water from ephemeral flow areas may carry sediment or other materials directly into streams (especially during wetter seasons).
- **forested wetlands and floodplains next to waterbodies.** Typically, these are wetter, weaker soils. They are more likely to develop ruts and produce rapid runoff into nearby waterbodies.
- **water diversions that concentrate flow.** Culverts, ditches, and other drainage structures may increase the amount of water flowing into the riparian management zone. They could also create a new

channel through the riparian management zone, reducing its effectiveness. In these cases, increasing the riparian management zone width and making sure the drainage structures and BMPs are properly installed will help disperse the water.

- **some stand conditions**. Some sites may warrant wider riparian management zones to maintain the wind-firmness of the stand or provide adequate shade on the waterbody.

NH law limits timber harvesting operations near surface waterbodies 10 acres or greater in size and any fourth order or higher stream. For further information contact the NH Division of Forests and Lands @ 603-271-2214.

Table 1.	
RIPARIAN MANAGEMET ZONE WIDTHS	
Side slope (percent)	**Width (feet*)**
0 - 10	50
11 - 20	65
21 - 30	85
31 - 40	105
41 – 50	125
51 – 60	145
70+	165
*Along the slope, on both side of the stream.	

Add picture from page 21 of color BMP

7. Log Decks and Landings

Log landings are the cleared areas in the harvest area where logs and other products are brought from the woods and piled, sorted, or stored before being loaded onto trucks. Log landings are sometimes referred to as log yards or decks. Landings are also where hazardous materials often are stored or used to maintain and repair equipment and roads. Please refer to the "Hazardous Materials" section on page **XX** for BMPs that deal with these substances.

Planning, Locating, & Construction

- Locate landings on sites with well-drained soils and gentle slopes whenever possible
- Locate landings out of riparian management zones and, if possible, at least 100 feet from waterbodies (including wetlands). If landings cannot be set back 100 feet from streams, pond, lakes, and wetlands, Settling basins should be used to minimize sedimentation from surface runoff. (see page XX) It is not uncommon to re-use an existing landing that is within 100' of a waterbody where relocation would result in greater overall impact to the land or water resource.
- Size the landing to meet the requirements of the equipment, the quantity and type of products, safety and other objectives.
- Layout skid trails and roads so that water cannot flow into or out of the landing where they enter.
- Mark the landing boundaries before construction begins.
- Use existing landings if possible. Determine if they can be reused with adequate erosion controls. If not, relocate them.
- Minimize the area of the landing that is stumped or grubbed. Logs may sometimes be piled on

relatively undisturbed soil or forest floor, within reach of loading equipment.

- Install drainage ditches, water bars, or berms to drain the landing to areas of undisturbed forest floor, or to road drainage systems that can handle the amount of water coming off the landing.
- Surface the landing with wood chips, stone, or aggregate if it will help stabilize the surface and shed water. Use these materials on top of geotextiles, if necessary.
- During construction, install temporary sediment barriers (such as hay bales, straw wattles or silt fences) to keep newly exposed soil from entering flowing water and riparian management zones.

Landing Maintenance

- Maintain the landing surface to keep water from collecting or channeling.
- Maintain drainage structures on roads and trails to keep water from entering the landing
- Install temporary or short-term measures (e.g. waterbars) on skid trails if significant rain is likely during operations.
- Allow landings to dry out after significant rainfall

8. Forest Roads

Forest roads are critical for accessing forest land and efficiently moving forest products. If designed, constructed and maintained correctly, forest roads, also called truck roads, can minimize impact to nearby water bodies and wetlands. Truck roads may alter or channel the flow of water, expose soil over a large area and get heavy use so special attention is needed including installing permanent crossings and water diversions to avoid problems.

Types of Forest Roads/Haul 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 is needed to meet both forest management and landowner objectives.

Temporary forest roads are designed and constructed for short-term use during a specific project, like a timber harvest. These roads are used to move wood and are built to support the weight of fully loaded trucks. When the project is done, the temporary road is closed, all crossing structures removed, and the road re-vegetated.

Permanent seasonal forest roads are maintained as part of the permanent road system for the property but are intended for use only when the ground is frozen or firm. These roads are generally narrower than permanent all-season roads and are built to lower engineering standards. Seasonal roads will generally have little to no surface gravel

Permanent all-season forest roads are designed for year-round use, but may still have use restriction at various times of the year, such as spring break up. All-season roads are built to higher standards and usually have gravel surfaces.

Things to consider:

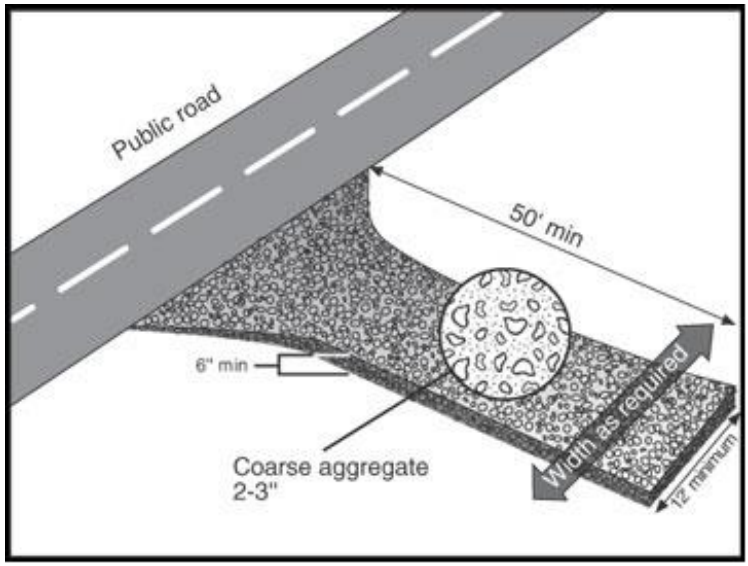
- Determine if the road or portions of the road will be temporary or permanent.
- Work with an experienced road builder who can provide guidance.
- Construct roads during dry periods and allow time for them to settle before using.
- Locate roads, as much as possible, away from water bodies and wetlands.
- Avoid locating roads on steep or unstable slopes
- Minimize road length and ground disturbance
- Road grades should be kept to 10% or less. Steeper grades are permissible for short distances.
- Identify appropriate stabilization, drainage and erosion control measures to be used.
- Plan for the long-term maintenance and use of the road.
- Contact utility companies when operating near power lines or crossing underground utilities.

Forest Road Construction:

- Shape roads to move water off of surface by using a crown, out-slope or an in-slope.
- Use gravel, crushed stone, geotextile or other surface to increase weight bearing capacity, shed water and further stabilize road.
- Maintain cut and fill slope at 2:1
- Stabilize construction areas where exposed soil may erode
- Use temporary sediment barriers such as silt fencing, hay bales or other devices to slow water flow and trap sediment. Ideally these should be limited to a drainage area of 0.5 acres or less.

Diagrams: out-slope road, in-slope road, crowned road

Constructed Entrance



Soil Stabilization

Soil stabilization practices are used when the soil is exposed and natural revegetation is inadequate to prevent soil erosion. Soil can be exposed during road and skid trail construction and grading and by heavy volumes of traffic. Some practices, such as seeding and mulching, are designed to hold soil in place and prevent it from moving,(erosion control) while other practices are intended to slow and capture sediment once it has begun to erode (sediment control).

Sedimentation is the deposition of detached soil particles, which have been eroded by flowing water. There are a variety of sediment control products to choose from, depending on slope length, slope steepness, and soil type. Silt fence, hay bales, and rolled erosion control products such as coir logs and straw wattles are designed to capture sediment until other measures, especially permanent vegetation, can be established.

Stabilizing Exposed Soils – Temporary Materials

Hay or **straw mulch** can help minimize soil movement, and usually lasts one or two seasons, holding the soil until the natural vegetation grows back. Mulch is often used after seeding exposed soil. Hay and straw are not effective in areas of concentrated flows.

******Unless certified weed- free, the use of hay or straw can result in the introduction of invasive plants.***

When mulching exposed soil with hay or straw, use enough mulch to cover the soil completely or nearly completely. A common guide is approximately 90 lbs. of mulch per 1,000 square feet (or about 2 square bales for a 30 x 30 foot area). On steep slopes (greater than 4:1 or 25%) or exposed windy sites, it may be necessary to anchor the mulch with staples, netting, or twine.

Brush, slash, and tops from harvesting are often readily available, and are an excellent means of stabilizing exposed soils until the area revegetates naturally. Brush typically does not need to be removed except if it falls below the normal high water mark of waterbodies.

- Use brush on trails that could erode and deliver sediment to streams. Wherever possible, put brush down before the soil becomes disturbed and the soil exposed. The more brush, the better.
- Use brush as a berm on the lower shoulder of roads running across slopes to help stabilize exposed soil and disperse water being shed off the road.
- Use brush on landings or similar high traffic areas (if it will not present a hazard to equipment).
- Use brush at the outfall of dips,water bars, and other drainage structures to help hold the soil and disperse concentrated runoff.

Seeding grasses that will establish themselves quickly can help minimize erosion of exposed soil. Temporary seeding works best on slopes less than 4:1 (25%). The recommended grasses for temporary seeding include winter rye (110 lbs./acre), oats (80 lbs./acre), or annual ryegrass (40 lbs./acre).

Temporary erosion control blankets are available in rolls and are made of a wide variety of materials. Usually they are biodegradable. They are often used with grass seed to establish vegetation as the blankets rot. Erosion control blankets must be in contact with the soil to prevent water flowing between the blanket and the soil. On slopes greater than 4:1, blankets may need to be anchored with staples or by other means. Blankets work best in ditch and swale sections (where there is concentrated runoff) when the slopes are gentle.

Stabilizing Exposed Soils – Permanent Material

Wood chips, waste wood, or bark mulch may last several seasons, depending on the material and its depth. Occasionally, these materials are combined with soil in an erosion control mix. Spread the material to a depth of 2–6 inches, primarily on slopes less than 4:1 (25%). Wood chips, waste wood, and bark mulch are not allowed in streams or where they may be subject to erosion.

Permanent erosion control blankets are usually made of synthetic materials and are used in high-flow areas such as ditches.

Gravel can provide adequate stabilization, especially on travel surfaces with low slopes and little concentrated flow. Ideally, gravel used in critical areas is screened and/or washed to remove the fines.

Riprap or cobbles are larger stones used to stabilize ditches, heavily traveled areas, and areas of high flow. They are also used to armor steep slopes (up to 1.5:1 or 67%) and culvert inlets and outlets. You can use riprap in combination with erosion control blankets to prevent flowing water from undercutting steep slopes. Use very large stone in combination with smaller cobbles and/or blankets.

Permanent vegetation or revegetation is commonly used to permanently stabilize disturbed areas. Permanent vegetation may include grasses, shrubs, and/or trees. Seeding is recommended on exposed soils within filter areas, at waterbody crossings, and at similar critical sites that are not stabilized by other means. Most other areas will reseed naturally within two years, provided BMPs have been used to control the water flow.

Wide varieties of seed mixtures for permanent revegetation are available. Usually, they contain combinations of creeping red fescue, annual ryegrass, tall fescue, flatpea, switchgrass, bluestem, deertongue, and other species. Native, non-invasive grass species are preferable if they are available and affordable. Commercially available "Conservation Mix" is often appropriate. A typical mix consists of: creeping red fescue (40%); annual ryegrass (31%); Dutch white clover (20%); birdsfoot trefoil (5%); and hairy vetch (4%). Select a seed mixture based on:

- The site conditions;
- How quickly the soil needs to be stabilized to avoid sedimentation;
- The time of year and predictable weather conditions;
- The soil's moisture and fertility; and
- Shade conditions.

Temporary Sediment Control Products

Silt Fence – Silt fence barriers are used where flow to the silt fence from a disturbed area occurs as overland sheet flow. They should not be used in areas of concentrated flows. Under no circumstances should silt fences be constructed in streams or drainages where there is a possibility of a washout.

Silt Fence Installation – Proper installation is critical:

- Install the silt fence by first setting stakes at least every 3 – 10 feet. Three feet between stakes is necessary for light fabric, while 10 feet between stakes is adequate when using extra strength fabric or wire mesh support fence.

- Follow the manufacturer's recommendations and choose a filter fabric capable of handling the

expected water flow. The fabric may be 15 – 36 inches high.

- Excavate a 4-inch deep trench upslope, along the line of stakes.
- Place an 8-inch skirt of fabric in the trench; staple the upslope side of the fabric to the stakes; then backfill and compact the soil.

Do not install silt fence across a stream

Silt fence diagram

Silt Fence Maintenance

Fences should be inspected periodically and maintained after rainfall.

Sediment deposition should be removed, at a minimum, when deposition accumulates to no more than one-half the height of the silt fence, and moved to an appropriate location so the sediment is not readily transported back toward the silt fence.

Silt fences have a useful life of one season. On longer timber harvest operations, silt fence should be replaced periodically as required to maintain effectiveness.

Remove silt fences when the timber harvest operation is complete and the area is stabilized.

Straw or Hay Bale Barrier - Straw and hay bale barriers are a type of temporary sediment barrier installed across or at the toe of a slope, to intercept and retain small amounts of sediment from undisturbed areas. They function

primarily to slow and pond the water and allow soil particles to settle.

******Unless certified weed- free, the use of hay or straw can result in the introduction of invasive plants.***

Straw or hay bale barriers should not generally be used across streams, channels, swales, ditches or other drainage ways or areas with concentrated flows. They should only be used as a temporary barrier for no longer than 60 days.

Hay bales diagram

Hay Bale Installation

- Position the bales in the trench and stake with at least two stakes per bale; and
- Backfill with soil on the uphill side to keep water from flowing underneath the bale.
- Do not install hay bales in the stream bed.

Rolled Erosion Control Products

Rolled erosion control products, such as straw wattles and coir logs, are products designed to intercept and keep sediment from movement. Straw wattles and coir logs are an alternative to hay bales and silt fence. They are cylinders of compressed, straw fibers wrapped in tubular woven jute-netting. In many cases, the straw is certified as weed-free. Biodegradable, flexible, and simple to install, they are useful in a variety applications such as streambank, wetland, and slope protection. Properly installed, they can be used as a check dam within swales and ditch lines. They generally last longer than silt fence and hay bales, and are biodegradable. Check with the product manufacturer for recommended uses and use limitations.

Rolled Erosion Control Product Installation:

- Dig a shallow depression (about 3 to 5 inches deep) across the slope where the wattle is to be installed.

- Place the wattle in the trench so that it fits snugly. Tightly pack the soil from the trench against the upslope side of the wattle. This will prevent water from running underneath it.

- Drive a stake into the center of the wattle, approximately every five feet.

ACTION PHOTO OR DRAWING OF A STRAW WATTLE

Drainage Structures

- Construct roadside ditches to carry runoff from the road surface.
- Divert water off the road surface and away from road.
- Space water diversions close enough together to control the volume and speed of water
- Use 15”-18” culverts, or larger, for cross drainage to minimize plugging and maintenance.
- Slow water flowing from diversion structures using brush or riprap or, if water cannot be diverted into riparian management zones, a settling basin.

Diversion Ditches

- They can be used on roads or skid trails with or without road-side ditches
- They are easy and inexpensive to install

- Take advantage of the natural dips in the topography to direct water away from road and skid trails. Do not direct runoff into lakes, streams, or wetlands.
- Be sure drainage ditch goes downhill.
- Rock and/or check dams can be used to slow water flow and capture sediment.
- Maintenance may be needed if ditch fills with sediment

Diversion ditch diagram

Broad-based dip

A Broad-based dip is a dip and reverse slope in a truck road surface with an out-slope to drain water. The broad-based dip is most appropriate for a road or skid trail with less than a 10% grade.

- Install after basic roadbed construction and before major use
- On grades steeper than 8%, surface dip with stone or gravel.
- Use dips on approaches to steep declines in heavily used skid trails
- Discharge area should be protected with stone, debris, or logs to reduce velocity of runoff and filter water
- Refer to Table 2 for spacing of dips

Reverse Grades

A reverse grade is a cross between a water bar and a broad-based dips. Like broad-based dips, they have a reverse grade (except it is shorter) and they tip water off the road. Like water bars, they may also rely on a mound of soil at the downhill side. Reverse grades can be used on haul roads having a slope of 10 percent or greater.

- Requires greater planning in skid trail layout but can be used after basic clearing and grading for roadbed construction after is completed.
- A 10 to 15-foot-long, 3-8 percent reverse grade is constructed into the roadbed by cutting from upgrade to the dip location and then using cut material to build the mound for the reverse grade.
- Locate reverse grades to fit the terrain as much as possible
- Reverse grades are not suitable for constantly flowing water
- Use in conjunction with other water control measures
- Is inexpensive and low maintenance
- Unsuitable for very steep slopes or hardpan soils

See spacing chart (Table 2)

Diagram of a reverse grade on a skid trail

Water Bars

A water bar is a reinforced berm constructed across a road to slow down and divert water off of the road surface.
They are best suited for closed roads and skid trails.
The water bar is easy and inexpensive to install
Water bars can be constructed using soil, logs, slash, sediment wattles, or even snow

Guidelines for installation:
- Install water bar at the top of any sloping road or trail and at spacing according to chart
- Water bars may be shallow or deep depending on the need
- Should be constructed at a 30°-35° angle.
- Should drain at a 3% out-slope on to undisturbed litter or vegetation.

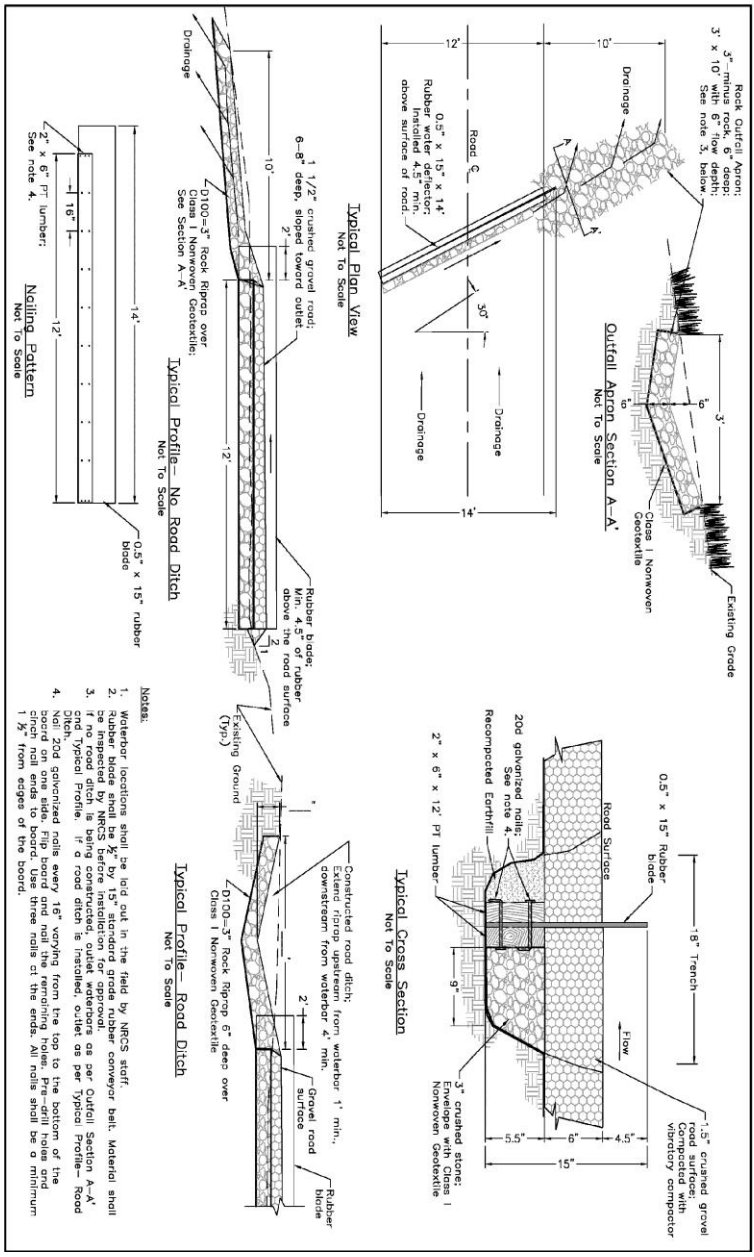
- Uphill end of water bar should extend beyond the side ditch line to intercept water flow.
- Downhill end of water bar should be open and extend beyond the edge of the road or trail to disperse runoff water onto undisturbed forest floor.
- Place rocks, slash, logs or other objects at end of water bar to disperse but not block water flow.
- If road will be used continuously, reinforce water bars, keep travel to a minimum, use only in dry weather, maintain and inspect routinely.

Water Diverter

A diverter is a physical barrier often constructed of used conveyer belting planted in the ground with one side standing up across the road to divert water from the road surface.

- Best used on low traffic, temporary roads
- Easy and inexpensive to install
- Can be used on steep roads
- Requires maintenance with buildup of debris
- Requires replacement if damaged

See table 2, page XX for spacing chart



Rubber Waterbar Detail

Settling basins

Definition: settling basins also known as sedimentation ponds, sediment traps or silt traps are constructed to contain sediment that primarily arises during road, landing or trail construction.

Purpose: To preserve the capacity of reservoirs, ditches and streams: to prevent undesirable deposition on forest, agricultural and developed lands: to trap sediment originating from road and landing construction; and to abate pollution by providing basins for deposition and storage of silt, sand, gravel and other detritus.

Criteria:

- Their size is site dependent, but they will generally be approximately 10 ft. long by 5 ft. wide by 3 ft. deep.
- They need to be cleaned and maintained on a regular basis until the sediment problem abates after 1 to 4 years.
- Typically basins are installed at the outlet of ditch lines, cross drainage culverts and other points where sediment may be deposited.
- The outlet should be to undisturbed forest floor a minimum of 100 ft above a stream, other surface water, wetland or vernal pool.

Permanent settling basins on highly erodible soils require detailed engineering design.

2 diversion ditch diagrams

Cross-drainage culverts

Culverts are most appropriate on heavily used truck roads and in more permanent installations. Install drainage

structures above steep grades, below bank seeps and where water will run onto landing or forest roads. The purpose is to collect and transmit water from one side of the road to the other by using a culvert.

- Install culverts at a 2-4% slope and at a 30°-45° angle to the road.
- Space culverts properly (see Table 2) to control water volume and speed.
- Use at least a 15-18” diameter-size culvert to minimize plugging and maintenance.
- Stabilize areas around the inlet and outlet with riprap and other material
- Extend the culvert at least one foot beyond the road fill on either end.
- Install culverts on top of adequate bedding material that is free from branches, stumps and rocks.
- Cover the culvert with compacted material to a depth of ½ the diameter of the culvert’s diameter (or a minimum of 1 foot) or to the manufacturer’s recommendations.
- Check and clean the culvert regularly to prevent blockage.

2 Cross drainage culvert diagrams

Open-top culverts

An open-top culvert, or imbedded trough, can be constructed from wood, concrete or steel. It is placed perpendicular to the road to catch runoff and divert it across and away from the road surface. An open-top culvert is most appropriate for low-traffic roads.

- Install flush with road surface and align at a 30% angle downslope.
- Allow inlet end to extend into cut slope or side ditch to intercept water.

- Allow outlet end to extend beyond any fill and empty onto an apron of rock, gravel or logs.
- Open-top culverts must be cleaned regularly to remove sediments, gravel and debris.

Open top culvert diagram

Table 2 - Recommended Maximum Distances between Drainage Structures on Forest Roads and Skid Trails

Road Grade (%)	Maximum distance between water bars (feet)		Maximum distance between all other drainage structures (feet)	
	High Erosion Risk (sandy or silt soils)	Low Erosion Risk (rocky or clay soils)	High Erosion Risk (sandy or silt soils)	Low Erosion Risk (rocky or 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

Stop Box

Historic stone culvert

Close out and maintenance

Most erosion and sedimentation from roads happens within two years of the operation. Road closeout using appropriate

BMPs can prevent damage and sedimentation of nearby streams and wetlands.

- Close out road sections as portions of the harvest are completed.
- Plan for long-term monitoring and maintenance of roads, particularly areas that are prone to erosion such as steep grades.
- Check drainage structures such as culverts and water bars to assure that they are functioning properly.
- Stabilize and seed (if necessary) exposed soil outside of travel surface, in ditches and areas that filter water flow.
- Reshape and stabilize road surface and ditches to prevent ruts and ponding & channeling of water within the road surface.
- Remove temporary sediment barriers such as hay bales and silt fences if area is stable.
- Prevent water from entering the road (or landing) from skid trails by using diversions.
- Protect road from unwanted use and damage by blocking the road.

9. Skid Trails

Skid trails are unsurfaced, single lane trails; usually steeper and narrower than truck roads; and used for skidding harvested products. **Many of the practices recommended for forest roads are also applicable to skid trails.** The main difference is that skid trails are usually temporary and are built to handle less traffic.

Planning & Layout

- If possible, lay out trails for winter harvests in advance when there is no snow on the ground. Ideally, lay out trails when the ground is bare and during wet seasons.

- Limit the number of skid trails to minimize soil erosion.

- Whenever possible, lay out main trails to avoid waterbodies and their associated riparian management zones, wet spots, seeps, wetlands, and the bases of slopes.

- Do not skid in stream beds and keep trails off the banks of waterbodies.

- Construct trails on the contour, if it is safe to do so.

- Avoid skidding straight up and down hills where possible. Remember that trail systems that run downhill to the landing tend to concentrate runoff.

- Divert water from the trails to the undisturbed forest floor.

- 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 where needed to minimize runoff and erosion. Grades greater than 15% should not exceed 300 feet in length.

- Harvest during appropriate soil and weather conditions (preferably on dry or frozen ground).

- Use existing trails if they provide the best long-term access. Consider relocating existing trails if both access and environmental impact can be improved.

Construction

- Construct trails using simple structures that divert water. Keeping water out of the trail not only prevents erosion, but also reduces equipment wear and extends the period that the trail is usable (both during and after wet weather).

- If possible, limit the use of equipment in riparian management zones, or harvest only on frozen ground.

- Limit the amount of disturbed soil in riparian management zones and make sure that any sediment is filtered out before it reaches surface water. This reduces the impact of skidding and forwarding.

- Use brush to reduce the amount of ground compaction the equipment causes, to prevent soil disturbance, and to stabilize areas of exposed soil in riparian management zones.

Skid Trail Water Diversions

- Install water bars or other diversions to move water off the trail, preferably before it reaches the riparian management zone.

- Locate water bars and other diversions frequently enough to prevent water from accumulating, based on Table **2**. On some sites, choosing appropriate locations for diversions may be more important than their spacing.

- Make water bars at least 6-12 inches deep, 6-12 inches high, and install them at a 30-degree angle to the trail.
- Extend the water bar inlet and outlet 1 foot or more beyond the trail to keep the diverted water from re-entering the trail.

- Use the terrain to incorporate "natural diversions" into the trail layout, to help divert water from the trail.

- Put brush in the trail, as needed, to help disperse water.

Water diversion diagram needed

10. Stream and Wetland Crossings

Stream Crossings

Properly installed stream crossings can minimize the impact on water quality. The crossing includes the entire section of a road or skid trail as it crosses the stream channel, the stream banks, and the buffer strip (riparian management zone) on both sides of the stream.

Stop Box

> Stream crossings may require a permit or notification from NHDES. Contact DES at 603-271-2147 or visit www.des.nh.gov for more information.

There are two types of stream crossings:

Temporary Crossings are generally used by skidders, forwarders and other equipment to keep equipment out of flowing water.
They include:

- Portable bridges
- Temporary culverts
- Log or poled fords
- Ice bridges

Permanent Crossings are intended to remain in place. Truck roads are often permanent and require more carful design, installation, and long-term maintenance.
Permanent crossings include:

- bridges
- culverts
- stone fords

For all crossings:

- Select appropriate crossing structure for stream shape, depth, water flow and terrain
- Plan stream crossings before road construction, trail layout and harvesting begin.
- Minimize the number of stream crossings.
- Identify the best available sites for stream crossings:
  - ✓ Relatively straight and narrow stream channel
  - ✓ Level (or minimal sloping) and stable banks on both sides of stream
  - ✓ Approach should be perpendicular to stream channel
  - ✓ Hard stream bottom if using pole or stone ford.
  - ✓ Install crossing when water is low and soil dry
  - ✓ Install away from fish spawning areas
  - ✓ Road ditches should not terminate in a wetland or stream
  - ✓ Stabilize approaches if necessary. Contact NRCS for site-specific seeding recommendations

Skidder Bridge (temporary crossing)

Skidder or temporary bridges are used for crossing streams or other wet low spots. When constructed or set properly they minimize the impact on stream banks, stream beds as well as protect water quality.

A skidder bridge is often constructed from materials on site (like hemlock logs) or built from wood or other materials for multiple uses. The size of the bridge is dependent on the size of the crossing (length and width and the size of the equipment which must pass over it. For a wooden panel skidder bridge plan go to http://www.vermontconservation.org/images/stories/flyer_6-08.pdf

- Look to place bridge at narrowest portion of stream
- Install bridges at right angle to the stream and align approaches
- Stream alignment should be straight at the crossing point
- Approaches should be level for at least 50 feet either side of the stream where possible.
- Stabilize crossing approaches with brush or similar material before and during operations
- Protect approaches by extending bridge well beyond stream bank
- Install bridge well above the stream's normal high water mark
- Use bridge decking and side rails to prevent material from falling into stream

Bridges and Culverts for both permanent and temporary crossings

Properly sizing and installing bridges and culverts in stream crossings is important. Good planning will prevent structures from failing or washing out, requiring expensive repairs and rebuilding. Washouts can significantly impact a stream's water quality.

Step 1.

Determine the degree of flooding the crossing needs to withstand without being damaged or washing out. The length of time the crossing will be in place must be considered.

Design for:

- Normal high water (1-2 year flood event) for a temporary skid trail in place during dry season
- 10-year flood event for a temporary road crossing and/or a temporary skid trail crossing that will remain in place during Spring runoff.
- 25-year flood event for a permanent road crossing.
- If in steep mountainous terrain or in a high hazard area consider designing for a greater flood event.

Step 2.

Determine the opening size needed to accommodate the expected flood event. The field method described here calculates opening size based on the actual stream dimensions at the crossing location. Use stream bank evidence to measure the normal high water mark, not just the existing water level.

Normal high water (1-3 year flood)
To determine normal high water multiply width of the stream by the average depth of the stream at crossing. This

gives the desired square foot opening of the crossing or size of culvert (see Table 5). If a bridge is used it implies all bridge components will be kept above the high water mark.

10-year flood event

Multiply the width of the stream X the average depth of the stream X 2.5. For culverts use Table 3 and Table 5.

Table 3.

10-Year Flood Crossing Opening Size (sq.ft.)

Stream Width	Average Stream Depth at normal high Water mark (ft.)			
Ft.	0.5	1.0	1.5	2.0
1		2.5	3.75	5.0
2	2.5	5.0	7.5	10.0
3	3.75	7.5	11.3	15.0
4	5.0	10.0	15.0	20.0
5	6.25	12.5	18.8	25.0
6	7.5	15.0	22.5	30.0

Bridge, arch or open bottom culverts may be preferred on larger streams.

25-year flood event

Multiply width of the stream X the average depth of stream X 3.5. For culverts use Table 4 and Table 5.

Table 4.

25-Year Flood Crossing Opening Size (sq.ft.)

Stream Width	Average Stream Depth at normal high Water mark (ft.)			
Ft.	**0.5**	**1.0**	**1.5**	**2.0**
1	**1.75**	**3.5**	**5.25**	**7.0**
2	**3.5**	**7.0**	**10.5**	**14.0**
3	**5.25**	**10.5**	**15.8**	**21.0**
4	**7.0**	**14.0**	**21.0**	**28.0**
5	**8.75**	**17.5**	**26.3**	**35.0**
6	**10.5**	**21.0**	**31.5**	**42.0**

Bridge, arch or open bottom culverts may be preferred on larger streams.

Step 3.

Design the bridge or culvert to meet or exceed the minimum opening size

For bridges or box culverts determine a width and height that multiplied together produce a result that is at least as great as the square footage you determined in step 2. Bridges should always be installed above the normal high water mark.

For round culverts, select a culvert size using Table 5 (page XX)

- Find the opening size in first column that is equal to or the next size up from the opening size you determined in Step 2.
- Find the culvert diameter in the right-hand column.

For pipe arches

- Calculate the required opening using Step 2.
- The arch is approximately ½ of the opening size of a round culvert with the same diameter.

Use Table 5 to determine the required pipe arch diameter.

Table 5.
Culvert Diameter and Opening Sizes

Opening Size (sq.ft.)	Diameter (inches)
1.75	18
2.40	21
3.15	24
4.90	30
7.05	36
9.60	42
12.55	48
15.90	54
19.65	60
23.75	66
28.26	72

Step 4.

Adjust bridge or culvert size to:

- Minimize disturbance to the stream channel and banks

- Allow for unrestricted normal flows
- Allow fish to pass when water is present
- Ensure that water velocity does not increase because of the crossing structure

When installing permanent culverts:

- Set culvert with the bottom slightly below the stream bed and at a 2-3% down- stream slope.
- Avoid hanging culverts which prevents fish passage.
- Extend culvert one foot or more beyond width of crossing
- Cover with compacted fill to a depth equal to half the culvert diameter and at least 1 foot deep.
- Stabilize the inlet and outlet of culverts and bridges using cobbles, timber abutments or other protective armoring.

2 Culvert diagrams

Fish Passage

Stream crossings that prevent fish from passing under or through them can reduce the amount of stream habitat available or, in some cases, disrupt fish spawning. Temporary crossings have less impact on fish habitat depending on the type of crossing, the season and the type of stream. Permanent crossings, if not well planned, may cause barriers to fish, frogs, turtles and other animals. Crossings should be designed to:

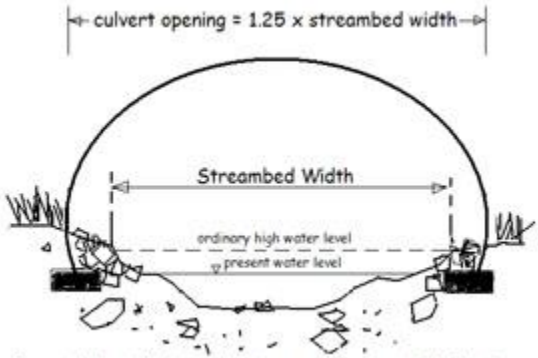
- Maintain the natural rate of stream flow. Make sure the structure is at least as wide as the stream channel at the high water mark.
- Minimize low-flow barriers which can create areas that are too shallow for fish passage
- Minimize exhaustion barriers such as long culverts that do not provide resting areas for fish

- Prevent perched (or hanging) culverts which prevent fish passage. Culverts should be embedded (25% of their diameter) into the stream bed.
- Reduce debris barriers that may accumulate at the inlet of undersized crossings
- Redevelop a natural stream bottom after installation

Open Bottom or Arch Culvert

When working in areas where fish passage is a concern or management priority, biologists prefer structures that pose the least risk to migration. Open-bottom culverts preserve the natural stream substrate and do not disturb the streambed**.** Common shapes include semicircular arch, elliptical arch, and concrete box culverts. These types of structures must be supported on footings located on both sides of the crossings. On gravel roads, footings may be a simple steel plate, but on paved surfaces, a concrete footing may be required.

In order to minimize stream sedimentation, flow interruption, and disturbance of fish during sensitive seasons, carefully consider the time and duration of culvert installation or repair. In general, in-stream work should occur during low flow conditions and should be scheduled so that it doesn't coincide with fish migrations, spawning, and egg incubation periods. Consult with local fish or water resources biologists in order to plan for the best times to avoid fish mating and migration activities in a particular stream.



Correctly installed open-bottom arch culvert with footings

Stone Fords

A stone ford is a permanent stream crossing used in streams with a solid streambed with banks that are stable and shallow. A stone ford should only be used on truck or forwarder roads during low-flow conditions when:

- A bridge or culvert is not practical
- Stream bed consists of gravel, cobble or bedrock
- Stream banks are low and stable
- Road traffic is minimal

Design considerations:

The single most important factor in designing a stone ford is protection against erosion during high flows. Careful consideration of flood size, frequency, and site selection is essential. Low-water fords are not the best alternative for streams where fish migration is a consideration.

Constructing a stone ford:

Locate fords in areas with a stable rock or gravel streambed. Install a vent, such as a box culvert, to allow water to pass through and to accommodate fish passage. The sides of the box support layers of 6" minus stone to allow water to flood and flow during high water, but keeps truck tires out of the water. Geotextile fabric may be placed over the stone to prevent the spaces between the stones from plugging with debris. A layer of small diameter stone is spread over the top of the fabric to act as a paving surface to protect the fabric and prevent plugging between the larger-diameter stone.

Approaches to stone fords should be protected with stone to prevent silt from carrying in to the crossing.

Maintenance of a stone ford:

Clean the box culvert or other structure may need to be cleaned periodically to ensure water and fish passage. If the ford has been overtopped with water, repair and maintenance may be required.

Stone Ford Diagram

Stop Box:

Skidding across stone fords is prohibited.
Stone fords should not be used when overtopped with water.
Stone fords installed in streams with a scour width exceeding 8 feet will require a standard wetlands permit. Call 271-2147 for more information

	Road Type				Traffic Volumes			Slopes	
	Permanent all season roads	Permanent seasonal roads	Temporary Roads	Skid Trails	High	Low	No Traffic Volumes	Rolling to steep slopes	Flat to Gentle Slopes
Cross Drain Culvert	●	●	●		●	●		●	●
Open Top Culvert	●	●	●			●	●	●	●
Water Diverter	●	●	●			●	●	●	●
Broad Based Dip	●	●	●	●	●	●	●		●
Reverse Grade			●	●		●	●	●	●
Water Bar			●	●			●	●	●
Diversion Dip	●	●	●	●	●	●	●	●	●
Settling Basin	●	●	●	●	●	●	●	●	●

Wetland Crossings

Wetlands play an important role in the environment by storing water in wet periods and slowly releasing it back into the surrounding ground and streams. Logging roads and trail crossings can affect the flow of water within or through a wetland. This changes how much water the wetland stores, the degree of flooding that occurs, and the rate at which water leaves the wetland. Such impacts can affect the health of the wetland and water bodies downstream.

Using BMPs in wetlands helps minimize two primary impacts: sedimentation and the alteration of water flow through the wetland soils. Sedimentation is primarily a concern for non-forested wetlands. Several wetland BMPs provide ways to increase the strength, or bearing capacity of the soil and to maintain water movement through the wetland.

Stop Box

Soil disturbance, fill and other alteration in wetlands requires a permit from NHDES at 603-271-2147 or www.des.nh.gov.wetlands

- The best BMP is to stay out of the wetland if at all possible. Construct permanent wetland crossings only if there is no reasonable alternative

- Get assistance from a professional engineer, licensed forester or wetland scientist if you need to construct a permanent road in a wetland.

- Minimize the length and width of the crossing through the wetland.

- If possible cross wetlands under frozen conditions. Avoid building winter crossings in areas with moving water, areas that do not freeze well or areas that are subject to break up during an unexpected thaw.

- Use temporary crossings if at all possible, using mats, log corduroy or brush.

- If a permanent wetland crossing, design crossings that are stable and will not restrict water flow during wet periods using materials such as stone and geotextile.

- Stabilize the approaches to wetland crossings (see stabilization on page XX).

- Determine long-term monitoring and maintenance of crossing. If a permanent structure, keep cross-drainage structures clear and monitor stability of road surface.

- After harvesting, remove temporary crossings. If crossing is composed of brush or corduroy, it may be best to leave the crossing in to decompose rather than pulling it out—creating more of an impact on the wetland.

Corduroy

Corduroy diagram

Corduroy is a method of using small logs, poles or slash to cross wet areas which do not have a defined stream channel.

- Place poles or logs perpendicular to the travel direction

- Crossing shall not be used when overtopped with water
- May be left in place after harvest is complete

Geotextile Fabrics

Geotextiles are synthetic permeable fabrics used to stabilize soil and other materials. Geotextile material provides separation of gravel and roadbed materials, increases the load carrying capacity, reduces the incidence of ruts and preserves the integrity and extends the life of the road surface layer.

Geotextiles also provide filtration and increased drainage capacity on wet or saturated soils, and they allow rapid water drainage in wet 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

There are a number of different types of geotextiles for many different uses. The manufacturer's directions should always be followed in their use. Contact a logging or forestry equipment supplier for more information.

11. Post-Harvest Wrap-Up

Most erosion and sedimentation from roads, trails, and landings happens within two years of the operation. Proper closeout ensures that future problems do not occur.

As a first step, identify the long-term monitoring and maintenance needs appropriate to the harvest site, communicate these to the landowner, forester, and logger and decide who is responsible for each task.

- Close out road sections and unused trails as portions of the harvest are completed.
- Make sure drainage structures are functioning correctly, are free of debris and accumulated sediment at their inlet and outlet, and are adequately sized for storm events.
- Reshape and stabilize the road surface and ditches as needed.
- Plant with recommended seed mix only if necessary to stabilize the soil, for wildlife, or for appearance. Otherwise, let natural vegetation establish itself. Contact UNH Cooperative Extension for information on site-specific seeding recommendations.
- Remove temporary sediment barriers such as hay bales and silt fences from roads, trails, and landings when site is stabilized.
- Install diversions such as water bars to prevent water entering roads, skid trails, and log landings.
- Smooth rutted trails if necessary to keep channels from forming, and to divert runoff directly into riparian management zones.
- If necessary, limit vehicle access to roads and landings to prevent damage and rutting (if this is compatible with the landowner's objectives).

- After harvesting, remove temporary stream & wetland crossings such as pole fords and temporary bridges.

12. Hazardous and other material storage

Fuels, oils and coolants

Oils, fuels, hydraulic fluids, coolants etc. are hazardous materials commonly used on logging operations. It is important to know how to handle these materials, how to avoid spills while maintaining or repairing equipment, and how to respond to accidents.

DRAWING FROM PAGE 89 with perhaps a list of what should be in a spill kit.

- Use appropriate containers for collecting and storing oils, fuels, coolants, or hazardous wastes.
- Store hazardous materials in designated areas and remove them from the site when they are no longer needed.
- Maintain and repair all equipment away from wetlands and water bodies.
- Maintain spill kits and other absorbent materials for mopping up spills on the job site.
- Sawdust may work well for small spills but larger spills require commercially available waste containment kits.
- Used absorbent materials must be disposed of properly
- If a spill occurs keep containment from flowing toward wetland or surface water.
- Call NH Department of Environmental Services when a spill occurs.

Stop Box:

For assistance with spills of hazardous materials,
call the NH Department of Environmental Services
Monday-Friday 8:00 am – 4:00 pm (603)271-3644
Other times (603) 271-3636

Temporary Sand and Salt Storage

- Locate sand and salt storage areas away from waterbodies, and wetlands.

- Locate storage areas on high flat ground near the road and away from water diversions that direct water into road ditches.

- Lay a liner on the ground where salt or sand will be stored and enclose the area with a berm to prevent movement of the material.

- Cover the sand or salt with a heavy plastic tarp.

- Remove remaining sand and salt when finished and return area to its original condition.

Appendix A

Frequency of Occurrence of Selected New Hampshire Tree and Shrub Species in Wetlands and Uplands

SHRUB SPECIES

OBLIGATE WETLAND SPECIES
(>99% in wetlands, <1% in uplands)

Common Buttonbush	*Cephalanthus occidentalis*
Cranberry, Large	*Vaccinium macrocarpon*
Cranberry, Small	*Vaccinium oxycoccos*
Rusty Labrador Tea	*Rhododendron groendlandicum*
Leatherleaf	*Chamaedaphne calyculata*
Cat Berry	*Nemopanthus mucronatus*
Rose, Swamp	*Rosa palustris*
Rosemary, Bog	*Andromeda polifolia*
Sumac, Poison	*Toxicodendron vernix*
Sweetgale	*Myrica gale*

FACULTATIVE WETLAND SPECIES
(67 - 99% in wetlands, 1 - 33% in uplands)

Alder, Speckled	*Alnus incana*
Azalea, Clammy	*Rhododendron viscosum*
Blueberry, Highbush	*Vaccinium corymbosum*
Broad-leaf Meadow-Sweet	*Spiraea latifolia*
Chokeberry, Red	*Aronia arbutifolia*
Dogwood, Silky	*Cornus amomum*
Elder, Black	*Sambucus nigra*
Maleberry	*Lyonia ligustrina*
Red Osier	*Cornus alba*
Rhodora	*Rhododendron canadense*
Spicebush, Northern	*Lindera benzoin*
Steeple-Bush	*Spiraea tomentosa*
Winterberry, common	*Ilex verticillata*

FACULTATIVE SPECIES
(Likely to occur equally (34 - 66%) in uplands and wetlands)

Arrow-Wood, Smooth	*Viburnum recognitum*
Bayberry, Northern	*Morella pensylvanica*
Chokeberry, Black	*Aronia melanocarpa*
Cranberry, Mountain	*Vaccinium vitis-idaea*
Eastern Poison Ivy	*Toxicodendron radicans*
Great Laurel	*Kalmia angustifolia*
Nannyberry	*Viburnun lentago*
Pepper-Bush, Coastal sweet	*Clethra alnifolia*
Rhododendron, Rosebay	*Rhododendron maximum*
Rose, Virginia	*Rosa virginiana*

FACULTATIVE UPLAND SPECIES
(1 - 33% in wetlands, 67 - 99% in uplands)

Barberry, European	*Berberis vulgaris*
Barberry, Japanese	*Berberis thunbergii*
Bitter-sweet, American	*Celastrus scandens*
Blackberry, Allegheny	*Rubus alleghaniensis*
Blueberry, Lowbush	*Vaccinium angustifolium*
Elder, Red	*Sambucus racemosa*
Hazel-nut, Beaked	*Corylus cornuta*
Hobble-Bush	*Viburnum lantanoides*
Juniper, Creeping	*Juniperus horizontalis*
Laurel, Mountain	*Kalmia latifolia*
Raspberry, Common Red	*Rubus idaeus*
Rose, Rugosa	*Rosa rugosa*
Teaberry, Eastern	*Gaultheria procumbens*
Witch-Hazel, American	*Hamamelis virginiana*
Yew, American	*Taxus canadensis*

OBLIGATE UPLAND SPECIES
(< 1% in wetlands, >99% in uplands)

Arrow-Wood, Maple-leaf	*Viburnum acerifolium*
Juniper, Common	*Juniperus communis*

TREE SPECIES

OBLIGATE WETLAND SPECIES
(>99% in wetlands, <1% in uplands)

Atlantic White Cedar	*Chamaecyparis thyoides*

FACULTATIVE WETLAND SPECIES
(67 - 99% in wetlands, 1 - 33% in uplands)

American Elm	*Ulmus americana*
American Larch	*Larix laricina*
Balsam Poplar	*Populus balsamifera*
Black Ash	*Fraxinus nigra*
Black Spruce	*Picea mariana*
Green Ash	*Fraxinus pensylvanica*
Northern White Cedar (Eastern Arborvitae)	*Thuja occidentalis*
River Birch	*Betula nigra*
Silver Maple	*Acer saccharinum*
Sycamore, American	*Platanus occidentalis*
Black Willow	*Salix nigra*

FACULTATIVE SPECIES
(Likely to occur equally (34-66%) in uplands and wetlands.)

Balsam Fir	*Abies balsamea*
Eastern Cottonwood	*Populus deltoides*
Gray Birch	*Betula populifolia*
Honey Locust	*Gleditsia triacanthos*
Ironwood (American Hornbeam)	*Carpinus caroliniana*
Red Maple	*Acer rubrum*
Slippery Elm	*Ulmus rubra*
Tupelo (Black Gum)	*Nyssa sylvatica*
Yellow Birch	*Betula alleghaniensis*

FACULTATIVE UPLAND SPECIES
(1 - 33% in wetlands, 67 - 99% in uplands)

White Ash	*Fraxinus americana*
Big-tooth Aspen	*Populus grandidentata*
Quaking Aspen	*Populus tremuloides*
Basswood, American	*Tilia americana*
American Beech	*Fagus grandifolia*
Paper Birch	*Betula papyrifera*
Sweet Birch	*Betula lenta*
Butternut (White Walnut)	*Juglans cinerea*
Eastern Red Cedar	*Juniperus virginiana*
Black Cherry	*Prunus serotina*
Choke Cherry	*Prunus virginiana*
Fire Cherry	*Prunus pensylvanica*
Flowering Dogwood	*Cornus florida*
Eastern Hemlock	*Tsuga canadensis*
Shagbark Hickory	*Carya ovata*
Hop Hornbeam, Eastern	*Ostrya virginiana*
Black Locust	*Robinia pseudoacacia*
Striped Maple	*Acer pensylvanicum*
Sugar Maple	*Acer saccharum*
Red Oak, Northern	*Quercus rubra*
White Oak, Northern	*Quercus alba*
White Pine, Eastern	*Pinus strobus*
Pitch Pine	*Pinus rigida*
Red Pine	*Pinus resinosa*
Sassafras	*Sassafras albidum*
Red Spruce	*Picea rubens*
White Spruce	*Picea glauca*
Black Walnut	*Juglans nigra*

OBLIGATE UPLAND SPECIES
(< 1% in wetlands, >99% in uplands)
None

Glossary of Terms

Armoring – to protect the beginning or end of a culvert, usually with large rocks, to prevent damage and crushing

Berm – a raised barrier to control, divert or direct water flow

BMPs – Best Management Practices are practices or a combination of practices determined by the state to be the most effective and practicable means of controlling point and non-point pollution at acceptable levels.

Bog – is a non-forested open wetland which may contain scattered trees and often has water at or near the surface part of the year

Broad-based dip – a dip or reverse slope in a truck road with an out-slope to drain water

Check dam – a small dam which can be constructed across a ditch, swale or drainage area to slow the water flow and allow for sediment to settle

Coir logs (straw wattles) – cylinders of compressed straw fibers wrapped in tubular woven jute netting

Corduroy – poles, logs or brush laid perpendicular to the direction of travel and used as a roadbed to cross a wet area l there isn't a defined stream channel.

Crossing – a structure or technique used to cross a stream or wetland area

Drainage or diversion ditches – a depression built to channel water

Ephemeral flow areas – small drainage areas that flow into streams but have no defined, continuous channel

Erosion control blankets – a blanket made from mulch or other organic material design to stabilize soil and prevent erosion

Facultative plant species – occurs equally in upland and wetlands

Facultative upland plant species – occurs between 1-33% of the time in wetlands

Facultative wetland plant species – occurs 67-99% of the time in wetlands

Forestry Notification – a NH Department of Environmental Services process by which a forestry operation is allowed to begin harvesting with minimal delay and still comply with BMPs

Forested Wetland – are dominated by trees and often have very little surface water. Forested wetlands can often be difficult to identify

Geotextile - Geotextiles are synthetic permeable fabrics used to stabilize soil and other materials

Hydrology – the properties, distribution and circulation of water on the surface of the land, in the soil and underlying rocks and in the atmosphere

Intermittent streams – streams that flow only a few months of the year or during wet seasons

Invasive – a non-native plant capable of moving aggressively into an area, monopolizing light, nutrients, water, and space to the detriment of native species, also

referred to as exotic, nonnative, alien, noxious or non-indigenous weeds

Landing (log yard or log deck) – a place where trees and logs are gathered in or near a harvest site for further processing and transport

Marsh – a low-lying area with standing water or saturated soil for a sufficient portion of the year that is dominated by reeds, cattails, sedge, or grass-like vegetation

Normal high water mark – a stream's typical high water level

Obligate wetland plant species – occurs 99% of the time in wetlands

On the contour – same level or elevation

Open-top culvert – is an embedded trough constructed of wood, concrete or other material to catch runoff and divert it across and away from a road surface.

Perched culvert – a culvert with its ends above the water level of the stream

Perennial streams – streams that flow year round

Permanent crossing – a crossing that is designed and constructed to remain in place

Permanent forest road – a forest road which will be used after the timber harvest is complete, bridges and culvert remain in place

Poled ford – a crossing constructed with small logs (poles) which are place in the stream perpendicular to the direction of travel

Reverse grade – a section of road with a gentle slope opposite the overall slope of the road. Its purpose is to slow water down and to direct it off of the road surface

Riparian management zone – are natural areas between a timber harvest, roads, landings and water bodies

Riprap (or cobble) – are large stones used to stabilize ditches and heavily traveled areas and areas of high flow

Sediment – soil material that has been detached, transported, suspended and settled in water

Settling basin – a depression created to trap silt or other sediment carried by runoff

Silt fence – a barrier constructed of geotextile, hay or other material to catch sediment

Skid trail – an unsurfaced, temporary single-lane trail used to skid wood

Slash – branches and sticks (tops of trees) which results from harvesting timber

Stabilization – a process or technique used to prevent soil erosion

Straw wattles (coir logs) - cylinders of compressed straw fibers wrapped in tubular woven jute netting

Stone ford – a permanent stream crossing constructed with rock

Temporary crossing – a crossing that is designed and constructed to be removed

Temporary forest road – a road that is not meant to be used after the timber harvest is complete therefore, BMPs like bridges and culverts may be removed

Vernal pool – is a type of seasonal wetland that lack and inlet and outlet. During the dry season it may only appear as an isolated depression

Water bar – is a reinforced berm constructed across a road to slow down and divert water off of the road surface

Water bodies – a significant accumulation of water such as streams, rivers, lakes, ponds, bays, estuaries, oceans etc.

Water diversions – culverts, ditches and other drainage structures to direct water flow

Water diverter – a barrier, placed perpendicular to the road at a slight angle to direct water off of the road surface

Watershed – a drainage area

Weight bearing capacity – the amount of weight a road or other surface can carry

Wetland – an area where the soil is saturated or flooded at least part of the year. It is identified by the hydrology, soil and vegetation

Wetlands minimum impact permit – a NH Department of Environmental Services permit required for some forestry operations

For More Information

Available Assistance

NH Division of Forests and Lands
NH Department of Resources and Economic Development,
PO Box 1856, 172 Pembroke Rd.
Concord, NH 03302-1856
(603) 271-2214
http://www.nhdfl.org

UNH Cooperative Extension, Forestry & Wildlife Program
214 Nesmith Hall, 131 Main Street
Durham, NH 03824
(603) 862-1028
http://ceinfo.unh.edu

NH Wetlands Bureau
NH Department of Environmental Services
PO Box 95, 29 Hazen Drive
Concord, NH 03302-0095
(603) 271-2147
http://www.des.nh.gov/wetlands

NH Fish and Game Department
11 Hazen Drive
Concord, NH 03301
(603) 271-2501
http://wildlife.state.nh.us

USDA Natural Resources Conservation Service
Federal Building, 2 Madbury Road
Durham, NH 03824-2043
(603) 868-7581
www.nh.nrcs.usda.gov

Additional Resources

NH Department of Environmental Services – Wetlands Rules and Law.
http://des.nh.gov/wetlands/rule-law.htm

Guide to NH Timber Harvesting Laws. (2014)
http://extension.unh.edu/resources/resource/253/Guide_to_New_Hampshire_Timber_Harvesting_Laws

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http://extension.unh.edu/goodforestry/index.htm

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www.parcplace.org

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