North Carolina Forestry Best Management Practices Manual to Protect Water Quality

Amended December 2021

Prepared by the North Carolina Forest Service,
a division of the North Carolina Department of Agriculture and Consumer Services.

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This forestry BMP manual was amended as allowed under 02 NCAC 60C .0101(b), with review provided by:

- Technical Advisory Committee for the Forest Practices Guidelines Related to Water Quality as established and defined under N.C. General Statute Ch.113A-52.1(c).
- Stakeholders identified by the N.C. Forest Service in affiliated fields of interest.

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Background History and Context of BMP Manual Updates

The previous 2006 Edition was developed from a 'clean slate' through a process taking more than four years with contribution, input, review, deliberation and final concurrence from the North Carolina Forestry Technical Advisory Committee (TAC), a multi-disciplinary advisory body authorized by G.S.113A-52.1(c) and consisting of experts in water quality, forestry, sedimentation, and other fields. The TAC's role is to: "assist in the development and periodic review of Forest Practice Guidelines Related to Water Quality," abbreviated as FPGs. Since BMPs are inherently linked to FPGs, and the 2006 Edition was a completely new product, the decision was made to engage the TAC during the manual's development. In addition to the TAC's active role in developing the 2006 manual, drafts of that manual underwent multiple rounds of external, third-party technical peer review, including federal and state environmental and natural resource agencies.

This 2021 Edition is not a comprehensive overhaul. Nearly 75% of the BMPs remain unchanged, but there are notable revisions and additions from the 2006 Edition, which are listed below. Many of the updates were sourced from the NCFS *Forestry Leaflets* created after the 2006 BMP manual revision. These short publications capture new or different information between manual revisions. While N.C. Forest Service staff served as the primary authors of the revisions included in this update, multiple rounds of stakeholder comments were solicited, including from the current Forestry TAC, to assist with verifying that the revisions are consistent with the principles of forestry BMPs and that they meet the codified definition in the FPG rules of being "*effective and practicable (including technological, economic and institutional considerations)*."

Notable Revisions from the 2006 Edition

Ch. 1: A new Part 6 was added (Connecting Resiliency and Forestry BMPs). Some information was reorganized and streamlined.

Ch. 2: Much of the detailed rule language was removed and placed in the online appendix 10. The reader is directed to the respective online source/citation for additional rule details. A new Part 4 was added (Threatened & Endangered Species) to describe the link between BMPs and protecting aquatic life.

Ch. 3: Preharvest planning steps were streamlined to provide enhanced guidance and resources.

Ch. 4: The entire chapter was re-written. BMPs were simplified to improve consistency in usage. Recommended SMZ width is standardized at 50 feet. Considerations are suggested for limiting harvest and disturbance in the SMZ. New exceptions are included for additional timber to be cut from SMZ. More BMPs for ditches and ephemerals.

Ch. 5: The chapter was split into three separate chapters. This chapter now describes BMPs for controlling runoff and capturing sediment. Information about rolled erosion control products were added. Rolling dips were added.

Ch. 6: Stream crossing BMPs from the former Ch. 5 were moved into this stand-alone chapter. Brush crossings, in which limbs/slash is placed into a channel, are no longer considered acceptable.

Ch. 7: Forest roads, skid trails and decks/landings BMPs from the former Ch. 5 were moved into this stand-alone chapter. Information about road standards, geotextiles, and road gravel were moved from former appendix items.

Ch. 8: The entire chapter was re-written. A new suite of BMPs for shovel/mat logging were added. BMPs for minor drainage were revised to encourage less disturbance on the site.

Ch. 9: This chapter consolidates information previously in Ch. 7-10. Content was streamlined to reduce repetition.

Ch 10: Contains the information previously in Ch. 11. Content was streamlined to reduce repetition. The seeding recommendations remain unchanged.

Appendices: These were re-organized. Phone numbers and agency names were updated. Previous appendix information relevant to a BMP chapter was incorporated accordingly. A new Appendix 9 was added, which outlines post-2006 published peer-reviewed literature related to forestry BMPs. Rules and regulations pertaining to forestry operations was moved to Appendix 10 and will be available online only so that rule changes can be updated.

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How To Use This Manual

What the BMP Manual Does

This manual provides practical, effective and economically feasible recommendations aimed at protecting water quality during forestry activities.

What the BMP Manual Doesn't Do

This manual does not provide a complete and full description of *all* possible rules and options for protecting water quality during forestry related activities. The degree to which BMPs are implemented should be based upon the site's conditions, while meeting landowner objectives. Using alternative practices is acceptable if the intent is to achieve the same or better results related to water quality protection and soil conservation.

BMP implementation helps, but does not insure, that a site will achieve compliance with the requirements of the North Carolina Forest Practices Guidelines Related to Water Quality, the federal Clean Water Act, the federal Endangered Species Act or other applicable regulations.

Notes on…

In this manual, you will find text in a box that further explains a concept or topic being discussed in that chapter. The header for these boxes will state
A Note on _____{ topic }_____.

Glossary of Terms

Select forestry terms are defined in NCFS Forestry Leaflet #FM-1, available from the publications section of the agency's website: www.ncforestservice.gov; and some terms are in the FPG rules.

The NC-BMP Field Guide

The *North Carolina Forestry BMP Quick-Reference Field Guide* includes numerous illustrations along with user-friendly summaries of BMP recommendations provided in this BMP manual.

Forest Practices Guidelines Related to Water Quality (FPGs)

In North Carolina, the performance standards defined by 02 NCAC 60C .0100 to .0209, Forest Practices Guidelines Related to Water Quality, must be met if a forestry operation is to remain exempt from submitting an erosion and sedimentation control plan, obtaining permits and meeting other requirements described by the North Carolina Sedimentation Pollution Control Act.

Other Required Practices

The recommendations in this manual are not formal regulatory guidance or legal interpretation from any federal or state regulatory agency. For your convenience, this manual includes citations of required practices and guidance documents that are known to exist at the time of this manual's printing. This helps assure that forestry activities protect water quality as defined by federal or state laws, rules, or other regulatory guidance documents.

Citations are clearly denoted in the manual using these techniques:

- The cited text is introduced as such
- The text is within "double quotation marks"
- The statement *<start citation>* appears at the beginning of the text
- The statement *<end citation>* appears at the end of the text
- In some cases, the document source of the rule or law is provided.

The citations and recommendations provided in this manual must not be considered as the final or most current version or interpretation of any rule, law or other regulatory guidance.

Chapter 1: Introduction to BMPs and Soil Factors

DISCLAIMER: ***The information in this chapter is for awareness, education, and reference purposes only. There are no actionable BMPs outlined in this chapter. It is not appropriate or intended for any hypothetical scenarios, example considerations, or information outlined herein to be assessed, surveyed or audited for the purposes of BMP implementation monitoring. The selection and use of BMPs is site-specific and should be tailored to meet landowner objectives while complying with applicable laws, rules, and guidance.***

Part 1 -- Why Best Management Practices (BMPs)?

To protect the biological, chemical and physical integrity of water. BMPs are crucial for stabilizing soils, protecting watersheds and producing high quality water. Extensive forestry research has demonstrated that forest management with BMPs effectively minimizes water pollution when installed correctly and in sufficient amounts. Without BMPs, forestry operations can negatively influence water quality by introducing chemicals or by changing sediment loads and nutrient levels, water temperatures, stream flow, and dissolved oxygen concentrations. Forestry ('silviculture') activities are noted as one of several contributors of nonpoint source pollution across the landscape.

In 1987, the U.S. Congress amended the Clean Water Act to incorporate nonpoint source pollution prevention. The sections within the Act that relate to nonpoint source pollution require states to develop management measures and guidelines that, when implemented, will reduce the contribution of nonpoint sources during land-disturbing activities, which include forestry.

These management measures have, over the years, been widely referred to as 'Best Management Practices,' or BMPs. Forestry BMPs are voluntary in North Carolina and are defined in the North Carolina Forest Practices Guidelines Related to Water Quality, cited at 02 NCAC 60C .0102 (4) as:

> <*start citation*>"A practice, or combination of practices, that is determined to be an effective and practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals." <*end citation*>

Part 2 -- The BMP Process

1. Planning

Planning will help you determine a site's conditions and applicable regulations. Knowing these site conditions, the type of operation you intend to conduct, and regulations will determine the type and amount of BMPs that you should consider. Planning is key to successful and effective use of BMPs.

2. Implementing

Correctly/effectively implementing BMPs will lead to (1) water quality and site productivity protection; (2) efficient and less costly forest operations; (3) landowner and public approval; and (4) professional improvement.

3. Stabilizing

Stabilizing disturbed soil areas is important to assure short-term water quality protection. In many cases, it is appropriate to stabilize inactive areas such as roads, skid trails, and log decks while the operation is still active.

4. Monitoring and Maintaining

Monitoring the condition of implemented BMPs can make you aware of their functionality. Maintaining BMPs at least until the site has stabilized can help protect water quality.

Part 3 -- The Runoff Process

Water that falls onto or flows across the ground either soaks in or runs across the surface. This surface flow is called runoff. Runoff can occur when the soil is saturated or precipitation falls quicker than the soils ability to absorb the water through its surface. It is common for the greatest amount of runoff to take place from just a few major rainstorms each year. This means forest operations may need to be adjusted or halted when severe rainstorms are forecast.

Several factors found naturally in the soil can affect its ability to act like a sponge, and determine how water will either absorb or runoff. By using BMPs and conducting forestry operations mindfully, you can protect the soil's ability to act like a sponge and allow water to soak in, rather than run-off. This helps prevent erosion and keeps nearby waterbodies protected from nonpoint source pollution.

BMPs provide one or more of the following functions to reduce runoff effects:

- Minimize potential sources of sediment and runoff.
- Confine sediment on-site.
- Delay and trap the movement of sediment and/or runoff to allow settling of sediment, absorption of nutrients and/or evaporation of water.

As you will see in the next section, BMPs also protect water quality from other potential harmful impacts that may not be directly related to runoff.

Part 4 -- Importance of BMPs

Properly using BMPs can help protect water quality from several potential harmful impacts. This section briefly outlines the major topics that BMPs typically address on forestry operations.

Controlling Sediment

Sediment is the most frequent water quality concern associated with forestry operations.

Sedimentation occurs when eroded soil particles are transported by the runoff process into a waterbody. While sedimentation is a natural process, too much can cause water quality problems. Therefore, many BMPs were developed to control runoff and sediment movement.

The amount of sediment that is produced on a site depends upon the:

- Natural soil erodibility
- Slope steepness and length
- Water absorption and storage capacity of the soil
- Volume and speed of surface water runoff
- Amount and length of time soil is exposed
- Degree of blockage for surface water runoff

With proper planning and implementation, forestry activities can occur in ways that minimize soil disturbance, slow and distribute runoff, while maintaining the soil's ability to absorb and store water.

Creating and/or protecting conditions that allow water to soak into the soil minimizes the potential for sedimentation.

Table 1-1 is a simplified example of relative costs for implementing certain BMPs for erosion and sedimentation control. In many cases, low-cost BMPs are equally as effective as high-cost options.

Table 1-1: Relative Comparison of Costs for Forestry BMPs.

BMP	Relative Cost
Pre-harvest planning and job site layout. Minimize bare soil. Maintain groundcover.	$
Functioning Streamside Management Zones (SMZs). Bridgemats for stream crossings.	$$
Replenish gravel; or add more water control structures, sediment traps, cross-drain culverts, straw bales, etc.	$$$
Having to stop your work to redesign and fix a problem. Returning to a site for stabilization after the fact.	$$$$$

Maintaining Hydrologic Functions

Forests are among the best land use for protecting natural hydrology for not only water *quality*, but also water *quantity*. Forestry operations should be done in a way that minimizes the negative impact on internal soil-water drainage, water holding capacity, runoff and absorption. Here are three examples where hydrology is especially important:

1. Stream crossings should be avoided whenever it is feasible. If one is needed, it should be established and used in a way that minimizes impacts to the hydrology of the stream and riparian area. Because of the close proximity of disturbance near water at a stream crossing, these locations have the highest potential for problems.

2. Conducting forestry operations in forested wetlands. Wetlands pose additional challenges since their hydrology often is complex and not easily defined. The BMPs outlined throughout this manual should be evaluated for their applicability in forested wetland sites.

3. Attention should be paid to minimize negative effects on soil structure and infiltration caused by intensive soil disturbance during a forestry operation. Intensive soil disturbance can lead to increased surface runoff and sediment transport on certain sites, both of which may impact water quality.

A Note on Intensive Soil Disturbance (rutted, churned, or soupy soils)

The level of soil impact can be influenced by site characteristics (climate, topography, soil type), timing of operations (wet/dry weather), and equipment use (weight and number of passes). Each site has a unique threshold at which soils could negatively affect site productivity. Generally, soils with a finer texture, greater water content, and more frequent and heavy traffic tend to be more susceptible to intensive soil disturbance. Words used to describe intensive soil disturbance include, but are not limited to: excessively rutted, soupy, or churned soils. These along with accelerated soil erosion can restrict plant growth by altering soil aeration, as well as water and nutrient availability.

A universal BMP is to minimize soil disturbance. However, in cases where soil disturbance is thought to have reduced site productivity beyond management objectives, a forester with experience in local logging operations should be contacted to assess and if necessary develop a strategy to maintain site productivity. In many such cases, mechanical site preparation and continued monitoring of disturbed areas can improve long-term site productivity.

Maintaining Water Temperature

Sunlight is a major factor that controls the water temperature in streams and small/shallow waterbodies.

Streamside Management Zones (SMZs) are not only intended to control sediment from entering the water, but also can help control the sunlight intensity and temperature of the water that reaches the stream. Leaving vegetation along streams suitable to shade the channel can reduce sunlight intensity and maintain similar stream water temperatures before forestry operations.

Excessive removal of vegetation along streams can increase the growth of nuisance plant materials within the water or along the riparian area. Increased light can cause aquatic plants to grow too thick, particularly in nutrient-rich waters. When this vegetation decomposes, the oxygen in the water is used up more than usual, which can harm fish and other aquatic organisms.

Forestry Chemicals

Chemicals are usually applied on a limited, short-duration basis over the lifetime of a forest area, usually only once every few years or even decades.

Application of pesticides, which includes herbicides, must be done by a licensed operator in accordance with state and federal rules. In addition, there are many water-quality BMPs for using forestry chemicals that are actually required, either by state or federal rules. These rules can be found on the product's label and must be followed. Chapter 9, Part 1 of this manual outlines additional BMPs to consider.

Managing Unique Soil Situations

Hardened Soil Surface

Surface-hardened soils (compacted or frozen) cannot absorb water as well, which leads to increased runoff, erosion and sedimentation potential. The soil's duff layer acts as a natural blanket, maintaining the soil temperature and allowing better water infiltration. Disking or tilling may improve water infiltration, along with widespread establishment of vegetated groundcover

Organic and Muck Soils

These types of soil have large amounts of organic matter, which alters the soil's degree of wetness. As a result, these soils may limit the operability of the site and/or require specialized equipment or techniques to be used so water quality is protected.

Shrink-Swell Clay Soils

Soils with these characteristics can swell-up when they get wet and quickly shrink when dry, forming large cracks and hardened surfaces. These soils are usually more susceptible to intensive soil disturbances, as described above. Additional measures may be needed to control runoff.

Removing Operationally-Introduced Organic Matter and Debris from Waterways

Contribution of organic matter (such as leaves, pine needles, limbs, tree-tops, etc.) by natural processes is important for the aquatic health of a waterbody. Organic matter is also a vital component of soil for maintaining good conditions for organisms and water absorption. The uppermost layer of organic matter atop the soil surface is called duff. This duff layer cushions soil from the impact of precipitation. Too much organic matter/debris can block the flow of streams and may cause nutrient enrichment. Excessive organic material deposited by a forestry operation should be removed in most cases.

<<< Helpful Hint >>> Review FPGs and state laws related to stream and ditch obstructions (Ch. 2).

Part 5 -- Landscape and Soil Factors to Consider for BMPs

The type of BMPs to use, and the amount needed on any given site can be linked to key **landscape** and **soil factors.** Some factors you can control such as slope length, while other factors such as soil type are not in your control. Understanding the basic layout and soil composition of the land to be managed can help you determine what kind of BMPs to use.

Slope Steepness and Length (landscape factor)

Steeper slopes increase runoff speed and erosional force. Uninterrupted slope lengths allow runoff to concentrate and will also increase the rate of soil erosion. In either case, select and implement enough BMPs to slow and spread out runoff and cover bare soil. For example:

- A short, steep slope on a skid trail or fireline may require more water diversions than an equally short section of skid trail or fireline with a gentler slope.
- A longer, gently sloping access road may need fewer broad-based dips compared to an equally long road having a steeper slope/grade.

Table 1-2: Effect of Slope on Soil Erosion Potential.

Potential For Erosion	Land Slope Percent (%)
Highest	7% or steeper
Medium	2% to 7%
Lowest	0 to 2%

Soil Structure (soil factor)

Soil structure defines how individual particles of soil are connected to each other. Some soils have particles that closely bind together which produces small pores within the soil. Other soils may have a structure that is blocky or bulky which produces larger pores.

Forestry operations should be done in a way to minimize significant changes to soil structure that may lead to water quality problems. Examples include:

- Operating when soil moisture is dry enough to prevent negative impacts on soil structure and infiltration.
- Minimizing intensive soil disturbances, such as rutting or compacting.
- Concentrating repeated passes of equipment traffic to primary trails to avoid widespread damage across the site.

A Note on Soil Bulk Density:

The total volume of pore space within a soil determines the amount of air and water that soil can hold. Bulk density is used to measure this volume:

-- A high bulk density means the soil is denser and has a lower amount of pore space volume.

-- A low bulk density means the soil is less dense and has a greater volume of total pore space.

Understanding bulk density and soil structure not only helps determine what kind of runoff control to use but is important for planning future tree growth. If pore spaces are limited, tree seedling roots can struggle to establish themselves, especially in heavy or droughty soils.

Soil Texture (soil factor)

Soil texture influences how much a soil is prone to erosion and how much water infiltrates into the soil. Generally, sandy and loamy soils absorb water faster than soils with greater silt and clay components.

While you have no control over soil texture, you can recognize the type of soil on the site and evaluate alternative access routes or adjust the BMPs and operations accordingly. For example:

- A soil with high erosion potential will likely require more BMPs than usual to control runoff before it picks up speed across the ground surface.
- A soil with lower erosion potential might be adequately stabilized simply with groundcover, since runoff may be a lower risk.
- An alternative trail route may be selected to avoid more challenging soil conditions.

Table 1-3 Effect of Soil Texture on Erosion Potential

Potential for Erosion	Soil Texture	Typical Description
Highest	Silt, silt-loam, loam, very fine sandy-loam Sandy-clay-loam, silty-clay-loam, clay-loam	Fine Textured
Medium	Clay, silty-clay, sandy-clay, Fine sandy-loam, sandy-loam	Coarse Textured
Lowest	Loamy-sand, sand	Coarse Textured

Infiltration Capacity and Water Absorption (soil factor)

These factors deal with how much water can infiltrate and be absorbed into the soil and how well water moves within the soil itself.

Soil will absorb water up to a limit, after which the water runs off the surface. If the space between soil particles is reduced, the movement of water within the soil can be lessened.

Some examples of practices that allow good water infiltration, absorption and soil water movement:

- Maintaining adequate organic matter and groundcover on the soil surface.
- Avoiding intensive soil disturbance.
- Tilling areas of compacted/rutted soil and establishing abundant groundcover.

Moisture Content (soil factor)

Soil moisture influences how much additional water gets absorbed into the soil at any given time.

When soil moisture is highest, the soil is close to an operational saturation point, and can be very susceptible to negative impacts on soil structure and usually produces greater runoff volumes. It can be difficult for water to soak into a soil that is already saturated, or is extremely dry and surface-hardened. Practices that can address moisture content include:

- Operating when soil is dry enough to prevent negative impacts on soil structure and infiltration.
- Minimizing intensive soil disturbances such as rutting or compacting.
- Using specialized equipment or operational techniques that minimize adverse impacts on soils that have a high moisture content.
- Installing additional BMPs to control runoff that may occur.

Part 6 -- Connecting Resiliency and Forestry BMPs

Generally, BMPs have been tested under historical normal rainfall situations. As precipitation patterns seemingly become more widely variable in intensity, seasonality, and duration, it may be appropriate to observe trends in BMP performance and evaluate how certain scenarios may warrant a modified approach to BMP usage; while still maintaining operational flexibility, BMP functionality, and management adaptability to meet landowner objectives.

Below are some relevant citations on this topic to provide background and context:

From the 2005 U.S. Environmental Protection Agency's National Management Measures to Control Nonpoint Source Pollution from Forestry:

"Two inches of rain in 24 hours adds 10 pounds of water in every square foot of soil."
https://www.epa.gov/sites/production/files/2015-10/documents/2005_05_09_nps_forestrymgmt_guidance.pdf

From the June 2020 North Carolina Climate Risk Assessment and Resilience Plan:

"A resilient North Carolina is a state where our communities, economies, and ecosystems are better able to rebound, positively adapt to, and thrive amid changing conditions and challenges, including disasters and climate change; to maintain quality of life, healthy growth, and durable systems; and to conserve resources for present and future generations."
https://deq.nc.gov/NCResiliencePlan

From the September 2020 North Carolina Climate Science Report:

- *"It is likely that annual total precipitation for North Carolina will increase."*
- *"It is very likely that extreme precipitation frequency and intensity in North Carolina will increase due to increases in atmospheric water vapor content."*
- *"It is likely that the frequency of severe thunderstorms in North Carolina will increase."*

https://ncics.org/programs/nccsr/

From the North Carolina FPGs, 02 NCAC 60C .0101(b):

"Implementation of the rules in this Subchapter shall recognize that extreme and unusual weather may cause reasonable and otherwise adequate application of protective measures to fail. Where such measures fail and the resulting effect is not in compliance with a rule of this Subchapter, the responsible party(ies) shall implement corrective measures."

Forestry BMPs are suitable to not only fix a problem but are also preventative measures to reduce the likelihood of a problem occurring; or minimize its impact if it does occur. Preventative BMP implementation often has shown to be more cost-effective than fixing problems afterward.

More than 75 years of research in the eastern U.S. has shown that basic and easy-to-implement forestry BMPs are effective in protecting water quality. However, when examining forestry sites where accelerated erosion or visible sedimentation led to a water quality risk, in nearly all cases there was insufficient implementation of the recommended BMPs, specifically:

(A) There were not enough BMPs to manage runoff (ex: waterbars, diversions, dips, pits, turnouts, cross-drains, culverts, silt fence, straw bales, check dams, etc.); and/or,

(B) There was widespread, prolonged lack of groundcover to stabilize disturbed bare soil.

Below are some hypothetical scenarios to illustrate how forestry BMPs can contribute to forest resiliency during adverse weather events:

> When a tropical system is forecast to pass over a logging job and bring substantial above-normal rainfall, it could trigger swift action -- before that storm arrives -- to install more BMPs and/or implement measures that are above and beyond the 'normal' day-to-day level of effort. Some possible examples include adding more water diversions, removing stream crossings more promptly, and/or adding more groundcover on actively disturbed soil.
>
> Occurrences of multiple windstorms in an area may justify examining if there are other factors that could be considered when determining SMZ width and the extent of tree harvesting from within the SMZ. Windthrown/blown-down trees into a waterway may contribute to water backing-up. Dislodged trees may damage streambank integrity, thus exposing the stream to a potential source of sedimentation. The SMZ width and/or extent of harvest (disturbance) may need to be adjusted in some places to mitigate the potential for windthrow, and to achieve a more diverse set of landscape-scale objectives that also benefit the landowner.
>
> Increased frequency, severity, and duration of intense rainfall has changed how some people think about where the 'active' floodplain is functionally located along some waterways. Elevated stormwater runoff and streamflow surges can also occur from increased development and impervious surface in the upstream watershed area. The SMZ is intended to protect the riparian area along streams. If there is an elevated risk of a stream overflowing out of its channel or eroding its banks, then it may be warranted to re-consider the traditional layout of a SMZ to account for more frequent streamflow surges. Likewise, culvert sizing may need to be adjusted and additional armoring may be needed on the culvert's headwalls to account for increased streamflow at a crossing.

The fundamental BMP principles outlined in this manual have shown to be effective. And there are recommended spacings (quantities) for some BMP structures provided. However, it is appropriate to adapt these recommendations to the site, the conditions, and the type of activity undertaken; all while meeting the landowner's objectives.

For further reference, the North Carolina Forest Action Plan describes the status, trends, and conditions of the state's forest resources. That plan includes recommendations that address the entire breadth of forestry in the state, including a section dedicated to managing and conserving forests for clean water. The plan is available on the N.C. Forest Service website and www.ncforestactionplan.com.

Chapter 2: Water Quality Regulations for Forestry

DISCLAIMER: ***The information in this chapter is: (1) for awareness, education, and reference purposes only; (2) is not a full description of all applicable regulations; and (3) does not constitute legal advice. There are no actionable BMPs outlined in this chapter. It is not appropriate or intended for any hypothetical scenarios, example considerations, or information outlined herein to be assessed, surveyed or audited for the purposes of BMP implementation monitoring. The selection and use of BMPs is site-specific, and should be tailored to meet landowner objectives while complying with applicable laws, rules, and guidance.***

Part 1 -- Introduction

A fundamental BMP is to recognize and understand the water-quality rules and requirements that apply to your forestry activity and/or site. This chapter may not be all-inclusive, but it is believed to highlight the laws and rules that are most often associated with forestry. More detailed information is available in Appendix 10 (only available online and not printed in this manual) and also on the NCFS website in the 'Water Quality' section, under 'Regulations.'

Nonpoint Source ("NPS") pollution can come from any land use, including forestry. The Clean Water Act requires states to implement programs to minimize, reduce, manage and prevent NPS pollution. States are required to set water quality standards that prescribe the maximum limits of many different pollutants, depending on the Designated Use for a stream, waterbody or wetland. All land-disturbing practices, including forestry, are expected to uphold the water quality standards for each Use Classification of the water features on the project site. Standards are more stringent for certain higher-quality waters. Implementing BMPs will help land-disturbing activities meet water quality standards.

Table 2-1: Summary of N.C. Surface Water Designated Use Classifications

Class	Primary Designated Use
B	Primary recreation on frequent or organized basis
C	Secondary recreation; fish consumption; aquatic life
FWS	Future Water Supply
HQW	High Quality Waters
NSW	Nutrient Sensitive Waters
ORW	Outstanding Resource Waters
PNA	Primary Nursery Areas
SA	Saltwaters suitable for shellfishing
SB	Saltwaters for primary recreation on frequent or organized basis
SC	Saltwaters for secondary recreation; fish consumption; aquatic life
Sw	Swamp Waters
SWL	Saltwater Wetlands
Tr	Trout Waters
UWL	Unique Wetlands
WL	Freshwater Wetlands
WS-#	Water Supply for drinking water, ranging from WS-I to WS-V.

All streams and waterbodies are required to meet the water quality standards for Class C, unless that waterbody is explicitly labeled with an additional use class (as listed in the above table), thereby requiring a higher level of protection.

Additional NPS considerations are in place for coastal zone areas, to meet the requirements of Section 6217 of the federal Coastal Zone Act Reauthorization Amendments of 1990 (CZARA). The CZARA requires coastal states with approved coastal zone management programs to address NPS pollution that impacts coastal waters. In North Carolina, this Act applies in the 20 coastal zone "CAMA" counties

described in Table 8-1 in Chapter 8. The FPGs and the BMPs described in this manual encompass the forestry management measures described in the 1993 USEPA guidance document for coastal NPS pollution, referenced as: *Guidance Specifying Management Measures for Sources of Nonpoint Pollution in Coastal Waters. USEPA Publication Number 840-B-92-002. January 1993*.

Technical Assistance: State Agencies

N.C. Dept. of Environmental Quality (DEQ): https://deq.nc.gov
- DCM: coastal marsh, CAMA and Dredge and Fill Law.
- DEMLR: erosion, sedimentation, dams, mining and stormwater permitting.
- DWM: petroleum discharge on the ground and waste management.
- DWR: buffer rules, sediment-in-streams, wetlands, petroleum discharge in water and overall water quality standards.

N.C. Dept. of Agriculture and Consumer Services: www.ncagr.gov
- N.C. Forest Service: FPGs and stream/ditch obstructions. www.ncforestservice.gov
- Div. of Soil & Water Conservation: soil stabilization, stream restoration and agriculture BMPs.
- Div. of Structural Pest Control and Pesticides: pesticide licensing and application.

Technical Assistance: Federal Agencies

U.S. Army Corps of Engineers: Wilmington District www.saw.usace.army.mil/
- Regulatory Permit Program for wetlands, Sec.404 and Sec.10-Rivers & Harbors Act

U.S Fish & Wildlife Service, North Carolina Field Office: www.fws.gov/raleigh/
- Threatened & Endangered species consultation, Critical Habitat, 4(d) Rules

Part 2 -- Forest Practices Guidelines Related to Water Quality (FPGs)

References: G.S. 113A-52.01, G.S. 113A-52.1, G.S. 113A-61.1.

Silvicultural activities are governed by the FPGs, codified in 02 NCAC 60C .0100 to .0209. The FPGs are narrative performance standards and they must be In Compliance to remain exempted from the full provisions of the N.C. Sedimentation Pollution Control Act (SPCA). The 9 FPG performance standards are included below for quick reference. These 9 standards, plus the background information and definitions for the FPGs, are available on NCFS Forestry Leaflet #WQ-1. The NCFS is the lead agency for doing FPG compliance inspections. To learn about the NCFS inspection process, visit the 'Water Quality' section of the agency's website, *www.ncforestservice.gov*.

<<< Helpful Hint >>> The FPGs were revised in April 2018, and are cited below for reference.

<*start citation*>

02 NCAC 60C .0201 STREAMSIDE MANAGEMENT ZONE

(a) A streamside management zone (SMZ) shall be established and maintained along the margins of intermittent streams, perennial streams and perennial waterbodies. The SMZ shall confine visible sediment resulting from accelerated erosion.

(b) Ground cover, or best management practices, within the SMZ shall restrain accelerated erosion.

(c) Access roads, skid trails, except as provided in Rule .0203 of this Section, logging decks and mill sites shall be placed outside of SMZs. When barriers such as property lines or limiting land features prohibit the location of any of these outside of SMZs, they can be located within the SMZs. When located within SMZs, there shall be effective erosion control and sediment control structures or measures installed to restrain accelerated erosion and prevent visible sediment from entering intermittent streams, perennial streams or perennial waterbodies.

02 NCAC 60C .0202 PROHIBITION OF DEBRIS ENTERING STREAMS AND WATERBODIES

Stream obstruction and the impediment of stream flow or degradation of water quality shall be prevented by keeping soil and debris from forestry-related, land-disturbing activities out of intermittent streams, perennial streams and perennial waterbodies.

02 NCAC 60C .0203 ACCESS ROAD AND SKID TRAIL STREAM CROSSINGS

Access roads and skid trails that cross an intermittent stream, a perennial stream or a perennial waterbody shall be installed so as to minimize the amount of visible sediment that enters that stream or waterbody. These crossings shall be installed so that:

(1) stream flow will not be obstructed or impeded;

(2) no intermittent stream channel, perennial stream channel, or perennial waterbody shall be used as an access road or skid trail;

(3) crossings are provided with effective structures or ground cover to protect the stream banks and stream channel from accelerated erosion;

(4) crossings shall have sufficient water control devices to collect and divert surface flow from the access road or skid trail into undisturbed areas or other control structures to restrain accelerated erosion and prevent visible sediment from entering intermittent streams, perennial streams, and perennial waterbodies; and

(5) ground cover, or best management practices, that prevent visible sediment from entering intermittent streams, perennial streams, and perennial waterbodies shall be provided within ten working days of initial disturbance and will be maintained until the site is permanently stabilized.

02 NCAC 60C .0204 ACCESS ROAD ENTRANCES

A forest access road entrance that intersects a paved road shall be installed and maintained to prevent visible sediment or other debris from being deposited onto the paved road to the extent that the visible sediment or other debris would enter an intermittent stream, a perennial stream, or a perennial waterbody.

02 NCAC 60C .0205 PROHIBITION / WASTE ENTERING STREAMS / WATERBODIES / GROUNDWATER

Measures shall be taken to prevent equipment servicing waste, petroleum, fertilizers, or other chemical waste from entering streams, perennial waterbodies, and groundwater that results in a violation of an water quality standard of the Environmental Management Commission in Sections 15A NCAC 02B .0200 - Classifications and Water Quality Standards Applicable to Surface Waters of North Carolina, and 15A NCAC 02L .0200 - Classifications and Water Quality Standards (related to groundwater).

02 NCAC 60C .0206 PESTICIDE APPLICATION

Application of pesticides shall be limited to those labeled for that intended use, shall be used in accordance with labeling and rules adopted by the N.C. Pesticide Board as set forth in 02 NCAC 09L .1005, Restricted Areas, and applied in a manner to prevent adverse impacts on water quality.

02 NCAC 60C .0207 FERTILIZER APPLICATION

When used, fertilizers shall be applied in a manner to prevent adverse impacts on water quality.

02 NCAC 60C .0208 PERENNIAL STREAM TEMPERATURE

Shade within SMZs associated with natural perennial streams shall be retained to protect those streams from temperature fluctuations that result in a violation of a water quality standard of the Environmental Management Commission as contained in Rule 15A NCAC 02B .0211 - Fresh Surface Water

Classifications and Standards which is incorporated by reference including subsequent amendments, and may be accessed free of charge at *http://reports.oah.state.nc.us*.

02 NCAC 60C .0209 REHABILITATION OF PROJECT SITE

Areas on the project site that have the potential for accelerated erosion to cause visible sediment to enter an intermittent stream, a perennial stream, or a perennial waterbody, shall be provided with ground cover or best management practices of adequate sedimentation control within 30 working days after ceasing any phase of an operation or beginning a period of inactivity. Sedimentation control measures or ground cover shall be required for any area that is contributing or has contributed visible sediment into an intermittent stream, a perennial stream, or a perennial waterbody, regardless of when the visible sedimentation occurred as a result of the forestry-related, land-disturbing activity. Treatment and maintenance of those areas shall be sufficient to restrain accelerated erosion and prevent visible sediment from entering intermittent streams, perennial streams, and perennial waterbodies until the site is permanently stabilized. <*end citation*>

Part 3 -- Summary of Additional State Rules

Stream and Ditch Obstructions

References: G.S. 77-13, G.S. 77-14; and FPG .0202.

Two state laws prohibit obstructing streams and/or drainage ditches. These laws apply in woodlands and elsewhere. It is important to recognize that these two state laws are different from FPG .0202, "*Prohibition of Debris Entering Streams and Waterbodies.*" Review the NCFS Interpretive Guidance Letter on Stream and Ditch Obstructions # IGL-2018.1, available at *www.ncforestservice.gov*. This letter explains how the NCFS addresses some frequently-encountered waterway obstruction scenarios.

A Note on Streams and Ditches in North Carolina

Historical stream dredging and channelizing in North Carolina have resulted in previously natural-looking streams now appearing more like a ditch. However, just because a stream may look like a ditch or canal, it still requires the same level of protection as a natural-looking stream. If you have doubts about the condition and status of a stream or ditch on your forestry site, you can obtain assistance from the NCFS or other qualified natural resources professionals.

River Basin & Watershed Riparian Buffer Rules

Reference G.S. 143-214.25A; and 15A NCAC 02B.

Additional (more restrictive) stream buffers are required on certain designated streams, as described in the "Forest Harvest Requirements" of six different river basin / watershed 'riparian buffer rules' that are administered by DWR. At the time of this manual's revision in 2021, the areas of the state where these rules apply are listed below:

- Catawba River mainstem and margins of the run-of-river lakes, from and including Lake James south to NC/SC border;
- Goose Creek Watershed (Mecklenburg and Union counties);
- Jordan Lake Watershed;
- Neuse River Basin;
- Randleman Lake Watershed;
- Tar-Pamlico River Basin.

These buffer rules have very detailed requirements and special limitations on forestry activities. The details for each rule are too extensive to include here. Consult with the NCFS and review the appropriate NCFS *Forestry Leaflet* for the buffer rule in your area.

Notes on River Basin & Watershed Riparian Buffer Rules

NCFS Role: The NCFS has authority to determine which streams are subject to the riparian buffer rule, but only for a forestry activity. The NCFS does not enforce these riparian buffer rules, but will notify DWR if an apparent violation is observed on a forestry site.

Eligibility to Harvest Timber: To be eligible to harvest timber from Zone 1 of the buffer rule, the tract must either: (1) be enrolled in that county's PUV tax program for forestry; or (2) have a forest management plan that was prepared or approved by a registered forester. If there is a buffer rule violation, then DWR may request a copy of these documents.

Stream Definitions: The stream definitions used in these riparian buffer rules are different from how streams are defined under the FPGs. Be aware of this difference and consult the rules citations or a professional who is familiar with these rules for help if needed.

Stream Identification: For the riparian buffer rules, subject streams must appear on the most-recently-published edition of either the soil survey manuscript book, or USGS 1:24000 topographic map (the Randleman Lake watershed rule includes a 'kick in' clause and some ditches -- consult with an expert for that rule). For the FPGs, any intermittent stream or perennial stream requires a SMZ, regardless if it appears on a map or not.

Stream Determination: The NCFS has foresters certified to examine streams and determine if it is subject to the riparian buffer rule. However, the DWR reserves the right to make the final decision.

Trout Stream Buffers

Reference: G.S. 113A-57(1).

Additional stream buffers on trout streams are not required for timber/forest harvesting, as long as the forestry activity is in compliance with the FPGs. This is because the forestry activity is not considered to be 'construction' or 'development'; and because FPG rule .0201 already requires that visible sediment be confined within a Streamside Management Zone (SMZ).

Water Supply Watershed Stream Buffers

References: G.S. 143-214.5(d1); and 15A NCAC 02B .0622.

Additional stream buffers on Water Supply (WS)-designated waterbodies are not required, as long as the forestry activity is in compliance with the FPGs and with other applicable forestry water quality standards such as the riparian buffer rules.

Spill of Petroleum and Other Hazardous Substances

References: G.S. 143-214.1, G.S. 143-215.77A, G.S. 143-215.85; and FPG .0205.

North Carolina law requires that discharges of petroleum products or other hazardous substances to any stream, surface water or land surface in close proximity to a stream or surface water, be removed or otherwise appropriately treated and that such spills be reported to the appropriate state agency.

There are specific rules on when you must notify the state of a petroleum spill. These rules are explained in part 2 of Chapter 9. For petroleum discharges onto soil, the Div. of Waste Management is the lead agency. For petroleum discharges into surface water, the Div. of Water Resources is the lead agency.

Local Ordinances

References: G.S. 160D-9-21.

Local governments are prohibited from adopting ordinances that restrict forestry activities, but that tract must either be enrolled in the forestry PUV program or have a forest management plan, to qualify for an exemption from local ordinances. Some local governments had their tree protection ordinances 'grandfathered in' when this law was passed. When harvesting timber on small parcels in city limits or within the extra territorial jurisdiction (ETJ), consider checking with that local government first.

Floodplain Permits

Reference: G.S. 143-215.54.

Forestry activities can occur in a flood hazard area without the need to obtain a floodplain permit, provided that the activity complies with local land-use ordinances and any other applicable laws or regulations. For example, compliance with the FPGs, Riparian Buffer Rules and with the federal 15 BMPs for roads and skid trails in wetlands is still required.

Temporary Driveway Access Permit

Reference: G.S. 136-90, G.S. 136-91, G.S. 136-92.1; and FPG .0204.

Temporary driveway access entrances for forestry/silviculture do not require a permit from the NCDOT, but limitations apply. The operator must be trained, and the driveway must be removed within six months of installation, or at the end of the forestry operation, whichever comes first. The road ditch must not be obstructed. If a permanent driveway access is needed, then a NCDOT permit will be required.

A Note About Mud & Dirt on the Highway

FPG .0204, "*Access Road Entrances,*" applies if mud/dirt/debris on a paved road can cause a water quality violation. If mud/dirt/debris on the highway will not cause a water quality problem, then NCFS personnel will usually suggest to the logger that the roadway be cleaned off as a best practice and for safety. In this type of situation where there is no water quality impact, the NCDOT has authority to require the roadway to be cleaned off. Also, if the mud/dirt is causing a public road safety hazard, then a law enforcement officer can require removal of the material from off the road.

Coastal Area Management Act (CAMA) / N.C. Dredge and Fill Law

References: G.S. 113A Article 7; and 15A NCAC 07K .0206.

Forestry activities that occur in an Area of Environmental Concern (AEC) do not require a CAMA permit, unless excavating or filling a coastal marsh or a State-owned lake. See chapter 8.

Pesticides

References: G.S. 143 Article 52; 02 NCAC 09L .1001-.1009, and FPG .0206.

There are several state laws and rules dealing with pesticide use, handling, licensing, applications, general recommendations, drift control, restricted areas and notification requirements. The extensive rules are beyond the scope of this Manual for discussion. The NCDA&CS Structural Pest Control and Pesticides Division oversees the pesticide rules. In addition, a NPDES (stormwater) permit may be required for aerial application of pesticides over a wetlands or waters of the U.S., if that aerial application meets certain thresholds of acres treated. The NCDEQ-DWR oversees this NPDES permitting (Pesticide General Permit #NCG-56). Contact them to find out if the aerial application triggers coverage under that permit.

Part 4 -- Threatened & Endangered (T&E) Species

North Carolina contains several plant and animal species that are listed, as either Threatened or Endangered under the federal Endangered Species Act. Many of these animal species live in streams, and it is expected that more aquatic-based animals in North Carolina will be added to the T&E list in the future. Examples of the type of aquatic animals that have been or may be listed include fish species, freshwater mussels and amphibians. The list of T&E species in North Carolina is available from the U.S. Fish & Wildlife Service (USFWS) website: *www.fws.gov/raleigh/es_tes.html.*

Critical Habitat

In addition to being a federally-protected species, some species have "Critical Habitat" designated and described by federal rule. This habitat is vital for the survival of that species. For aquatic species, this usually includes segments of streams and rivers. It is a good idea to recognize if your forestry activity is next to or nearby a Critical Habitat and take extra effort to fully implement all appropriate BMPs.

The USFWS maintains an online map viewer that highlights final and proposed designated Critical Habitat. The map is available from the USFWS Environmental Conservation Online System. To view the online mapping tool, follow these steps:

1. Go to *ecos.fws.gov*.
2. Click the bullet point "Critical Habitat Report". This takes you to a new website.
3. On this new website, click the bullet point "**online mapper**". This takes you to a new website. (Note: ArcGIS shape files are also available to download).
4. On this map viewer tool, you can zoom-in to the map or search by address.

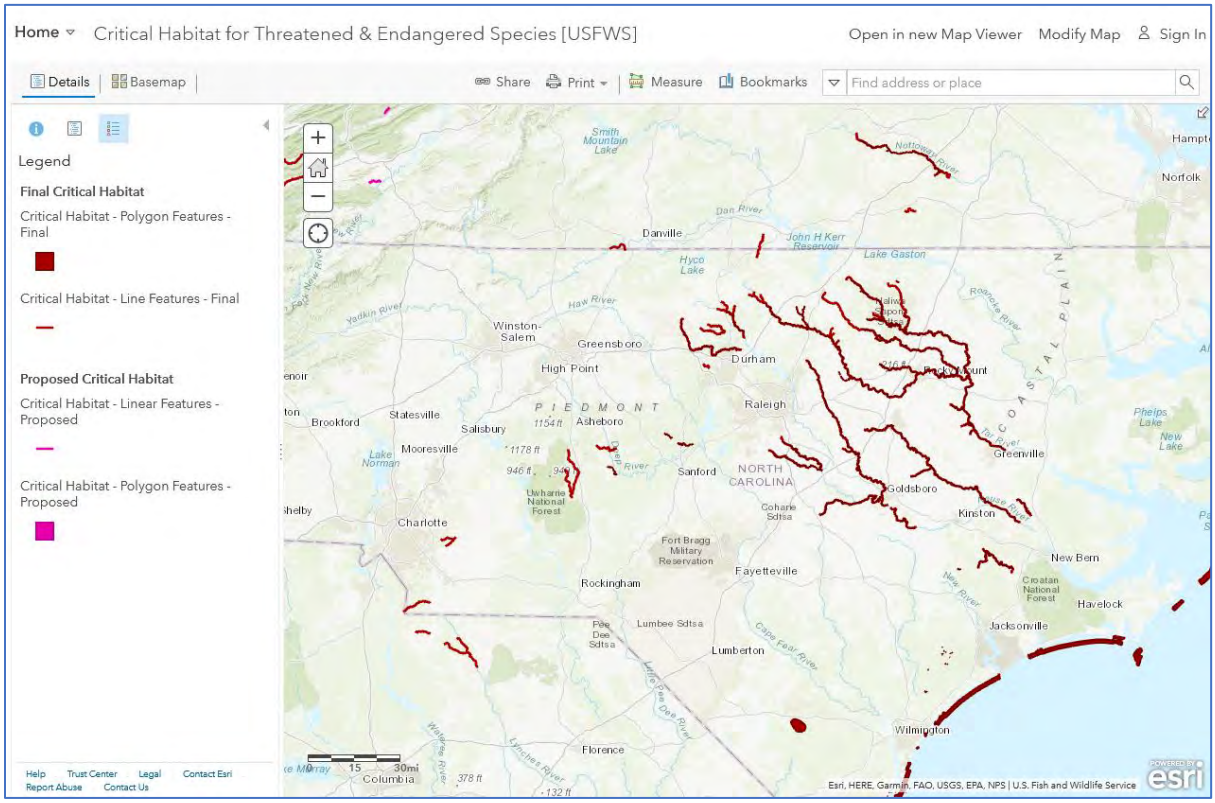


Figure 2A: Screenshot image from the USFWS Critical Habitat map viewer

Picture note: *The actual locations of Critical Habitat may be different from what is shown by this image. This is only for your awareness and is not to be used for decision-making.*

4(d) Rules

The Endangered Species Act prohibits "take" of a Threatened or Endangered species unless the USFWS issues a permit. However, section 4(d) of the Act can allow exceptions to the permitting requirements if an 'incidental take' occurs as a result of specific activities that are spelled-out in federal rule. These permit exceptions are known as "4(d) rules", and usually include conditions that must be met, in order for that activity to receive the exception from permitting in the event of an incidental take.

Recently, some 4(d) rules have been adopted or proposed for aquatic animals in North Carolina, and those rules include provisions for silviculture and forest management activities. When adopted, each 4(d) rule is for an individual species, and, for aquatic animals, the required conditions of the 4(d) rule would apply to any waterway where the listed species occurs.

Examples of 4(d) rule conditions may include: establishment of a SMZ; controlling sedimentation; maintaining stream temperatures; and the use of forestry BMPs to the maximum extent practicable.

The NCFS has a set of information summary leaflets on the "Regulations" page of the "Water Quality" section of its website, www.ncforestservice.gov. Those leaflets outline the 4(d) rule requirements for aquatic species in North Carolina.

For reference, the definitions of the terms "take" and "harm" are provided below. Note that it can also include the animal's habitat:

> "Take": To harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct.
>
> "Harm" (as used in the definition of "take"): An act which actually kills or injures wildlife. Such act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding or sheltering.

Considerations for T&E Aquatic Species

Most T&E aquatic species in streams require:

...clean water with no sedimentation,
...stable/consistent water temperatures, and
...swift-flowing water without obstruction.

These attributes can be protected by applying BMPs before, during and after a forestry activity.

Below are some considerations that may warrant attention if a forestry activity occurs on a site that has a waterway either containing a T&E species, and/or is designated as Critical Habitat:

- Can waterway crossings be avoided? If not, can temporary bridgemats be prioritized for use?
- Can a substantial SMZ be retained with little or no harvesting, and meet the owner's objectives?
- What areas may need extra erosion & sedimentation control measures?
- Can the forest be managed in a way that avoids the need to apply fertilizer or herbicide within the SMZ; while still meeting the landowner's objectives?
- If using prescribed fire, can the waterway be used as a natural fire break instead of plowing or blading a fireline along the SMZ edge?

Forestry BMPs have shown to be effective **when properly implemented**. The BMPs will protect water quality and associated aquatic habitat **but must be applied early, often, and in abundance**.
High implementation of BMPs can demonstrate that forest management is the 'highest and best use' to sustain habitat for all types of wildlife. The North Carolina Wildlife Action Plan has detailed information about wildlife needs and priorities: www.ncwildlife.org/plan.

Chapter 3: Planning Forestry Operations and BMPs

Planning assists you with identifying sensitive areas and applicable BMPs to protect water quality during and after the forest operation. While a written plan/contract is not required to conduct silvicultural operations, it is a wise practice to maintain written records of any forest management activity. A good plan and adequate supervision are key to a successful forest operation.

A written plan or contract can:

- help you to remember to consider all factors
- document your efforts to properly plan
- minimize miscommunication
- allow you to easily share it
- be simple, detailed, and effective

Loggers, landowners, timber buyers, foresters and anyone else who has a financial stake in the forestry operation, should take an interest in making sure BMPs are properly implemented, maintained, and functioning. Planning affords you time to know where special attention may be needed on a site, and is a cornerstone of sustainable forest stewardship.

Part 1 -- Forest Management Plans

The most important goal of a forest management (FM) plan is to make prescriptions or offer options on how the forested area should be managed in order to achieve the landowner's objectives.

Forest management plans should include a description of how water quality will be protected when management activities are undertaken, and plans should denote areas on the property that may require special attention. These plans are most commonly available from private consulting foresters, the N.C. Forest Service, forest industry programs or other natural resource agencies or professionals.

Examples of special areas include streams or ditches, waterway crossings, springheads, gullies, sink holes, or wetlands. A plan usually includes a summary of applicable environmental rules.

Specific recommendations for BMPs may not be included in a FM plan, but may be more appropriate for a project-specific preharvest plan, or other operational plan, once a more detailed site exam occurs.

In addition, the NCFS has a supplemental guide entitled: "*Managing Forests for Water: A Guide to Developing a Forest Watershed Management Plan*." This guide is available from the NCFS website.

A Note on When Forest Management Plans are REQUIRED

DWR riverbasin and watershed 'riparian buffer rules'

- The buffer rules for specific riverbasins or watersheds require a forest management plan to be in place before any timber harvesting can occur within Zone 1 of the buffer rule area.
- Refer to each NCFS *Forestry Leaflet* in the Appendix for more information.

Forestry Present-Use Tax Valuation of Property

- For a landowner to receive a forestry-use valuation on his or her property, a forest management plan must be in place. Each county tax assessor's office has different interpretations. Refer to your local tax office.

Part 2 -- Preharvest Planning

A preharvest plan provides greater detail than a forest management plan and should include descriptions of BMPs or other measures that will be implemented to protect water quality. A generalized five-step preharvest BMP plan list is outlined below for your reference. You should modify it to fit your specific needs. Note that the N.C. Forest Service can provide technical assistance throughout the process of forest management.

Five-Step Preharvest Plan for BMPs

Step 1 - Review rules that apply for water quality (and/or other rules)

- N.C. Forest Practices Guidelines Related to Water Quality
- NCDWR riverbasin and watershed 'riparian buffer rules'
- Wetland rules and requirements (state and federal)
- Threatened and Endangered (T&E) species considerations (Critical Habitat)
- Other forestry-related rules: waste disposal, burning, fluid spills, etc.

Step 2 - Establish and understand forest management and landowner objectives

- Speak with the landowner to understand what outcomes are needed related to the property access system. For example, will the roads/trails/stream crossings be temporary or permanent?
- When possible, discuss site history and previous land uses with the landowner and/or neighbors.

Step 3 - Review maps and photos

- Examine the site using office tools. Download and/or print topographic, soils, aerial maps and other applicable maps or photos.
- Identify parcel and harvest boundaries, property rights-of-way or easements.
- Identify potential access to the property by rights-of-way or easements and onto public roads.
- Mark important features on the maps and/or photos, such as power line and pipeline hazards, potential skid trail routes, soft/challenging soils, etc.
- Make notes as necessary to prepare for the tract visit.

<<< Helpful Hint>>> Topography/terrain of the tract can help you determine the placement and estimate cost of roads, skid trails, firelines, decks, crossings and their respective BMPs. Slope is a factor that influences the amount and speed of runoff that will need to be controlled and/or captured. Soil conditions and the volume and spacing of timber can influence where roads and decks are placed, as well as the operating window of time suitable for heavy equipment. See Ch. 5, Part 1 for BMPs on runoff control.

Step 4 - Visit the site

Take the maps and notes from the previous step to the tract. Reference them in each of the following:

Tract Layout

- Verify access to the property by rights-of-way or easements and onto public roads.
- Ensure that timber sale boundaries and/or ownership boundaries are well marked and visible.

Streams, Waterbodies and Hydrology

- Recognize how water moves through the site. This will influence how a harvest should be conducted and will influence the type and amount of BMPs to be implemented.
- Locate streams and waterbodies that will need protection.
- Establish and visibly mark Streamside Management Zone(s) (SMZ) according to FPG .0201 (see Chapter 4) and/or riparian buffer rule (see Ch. 2, Part 3). Be sure to communicate how you distinguished these areas with everyone on the job site.

Stream Crossings

- Determine if a stream crossing is necessary.
- Evaluate the entire stream reach to determine the best practical crossing location and method.
- Clearly mark and distinguish crossing locations from SMZs and riparian buffer rule zones.
- Prepare to use and make note of BMPs needed to meet FPGs during and after the operation.
- Review Ch. 6 for further recommendations pertaining to stream crossings.

Access Roads and Entrances

- Establish access from the site onto public roads. This may require obtaining N.C. Department of Transportation driveway permits.
- Prepare to use measures that minimize mud and debris from being dragged onto public roads.
- Provide a suitable sight-distance at the public road entrance point. Warning signs should be considered along public roads to warn oncoming traffic.
- If a new road must be built, establish the control points and road right-of-way through the tract to lay out the road before construction occurs.
- Refer to Ch. 7, Part 1 for BMPs related to forest roads.
- Refer to Ch. 8, Part 5 for required practices for roads in forested wetlands.

Skid Trails and Decks

- Plan to minimize the number and size of skid trails and decks.
- Locate skid trails and decks as far from waterbodies as practical given the site layout and conditions.
- Prepare to use measures that minimize soil disturbance and erosion along skid trails and decks.
- Different types of logging systems may require different types and/or sizes of skid trails and decks. Recognize this need and plan accordingly.
- Refer to Ch. 7, Part 2 for BMPs for skid trails and decks.

Step 5 - Finalize and communicate the pre-harvest plan

- Develop a plan to evaluate and repair BMPs during and after the operation so that FPG standards are met. Specify a heavy precipitation event threshold to evaluate and repair BMPs.
- Update the site map, based on observations during the tract visit. Be sure to include expected BMPs and notes for important features. Refer to Figure 3A for an example of a preharvest map created using the Forestry Preharvest Planning Tool: https://www.ncmhtd.com/NCFS/FPPT/fppt/Index.aspx. Refer to Figure 3B for an example of a hand-drawn preharvest map.
- Determine which portion of a site will be harvested first and have a contingency, or backup, plan if site or soil conditions deteriorate.
- Specify who is responsible for stabilizing the different areas of the site (see Ch. 10, Part 1).
- Specify how BMPs will be monitored and maintained so they continue to function effectively.
- Communicate this plan. Make sure workers on the job site understand what the site looks like, and what to expect when it comes to BMPs, rules and water quality protection. This is especially valuable for heavy equipment operators.

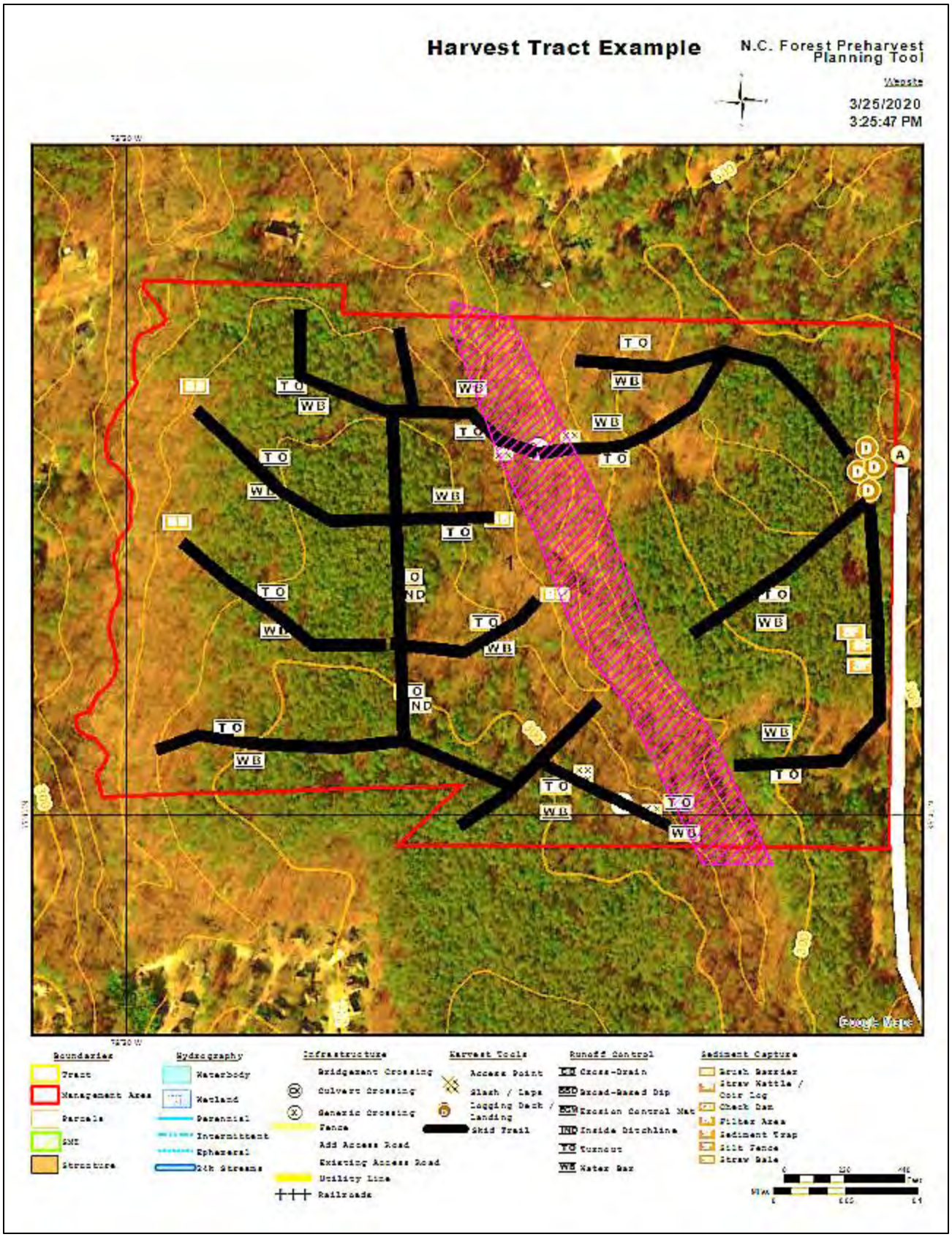


Figure 3A: Example of a preharvest map created with the NC Forest Preharvest Planning Tool

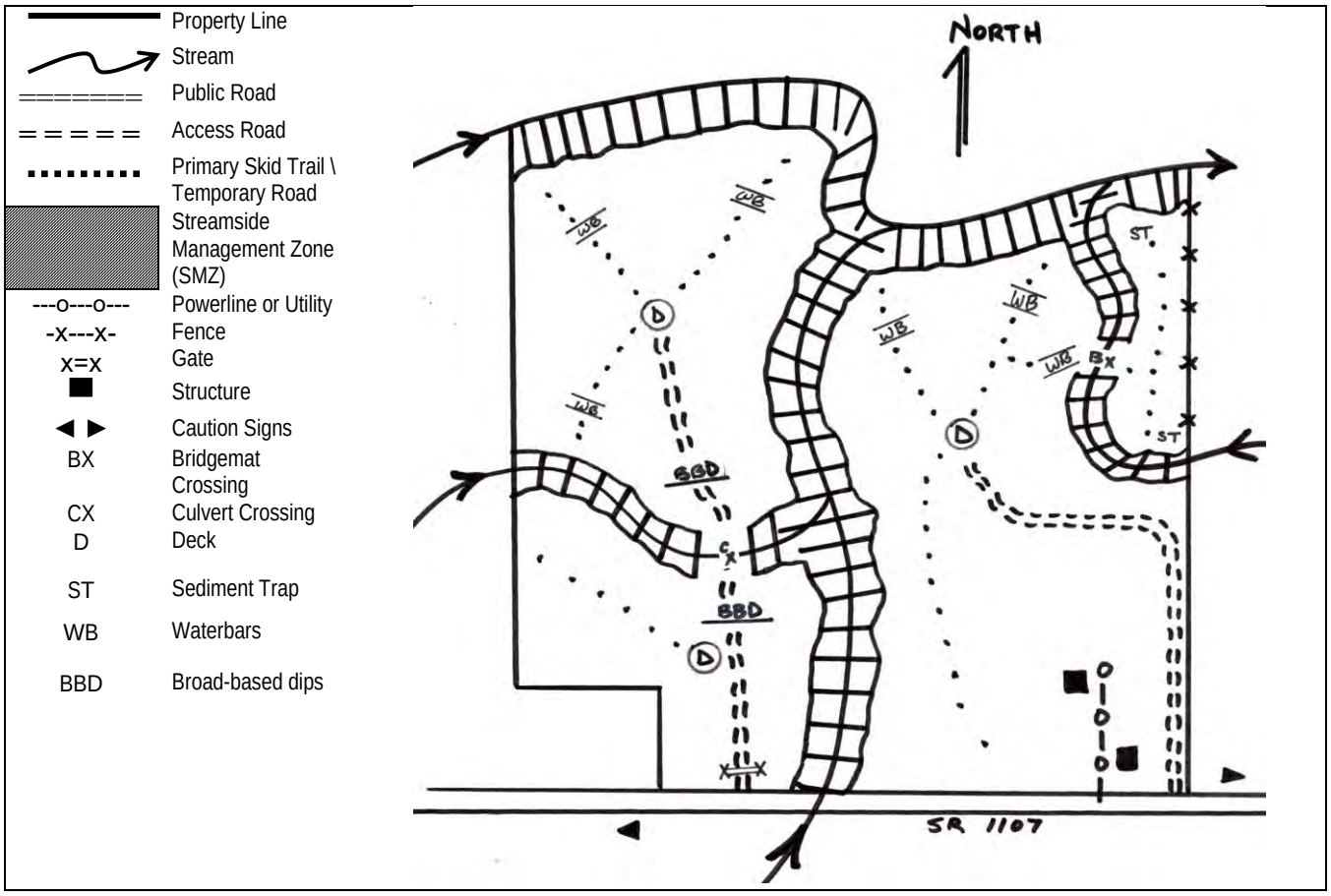


Figure 3B: Example of a detailed, hand-drawn preharvest plan map

Part 3 -- Logging Systems Considerations

Logging equipment is designed to do specific tasks within a set of operating conditions. Using tools and equipment beyond the scope for which they were designed can result in increased harvesting cost and/or undesirable environmental impacts. When selecting logging equipment configurations consider: (1) slope, (2) terrain shape, (3) transportation distance, (4) soils, (5) tree size and volume per acre, (6) tract size, and (7) road and skid trail construction and maintenance costs.

The logging system and type of harvest can influence the location and layout of roads, skid trails and decks. Roads and skid trails are the most common source of sedimentation. As a result, it is worthwhile to consider the relationships between the type of logging system and the implementation of BMPs:

1. Long tractor-trailers may require wider access roads and larger turning areas than straight-body trucks. Likewise, chipping operations usually require wider, flatter roads so the high-dimension chip trailers remain stable during transport. These wider road surface areas may need additional BMP attention for effective erosion and sedimentation control.
2. A harvest with many different log products can require larger deck areas for the sorting and handling of multiple log stacks. A larger log deck with exposed soil may need additional BMP attention for effective erosion and sedimentation control.
3. A harvest with intensive biomass utilization may require planned retention of enough leftover logging slash/laps/debris that can be used to stabilize skid trails, log decks, and skidder stream crossing approaches.

Part 4 -- Planning Resource Aids

Many resources are available to aid in the planning process. Appendix 4 provides a list of sources where some of these aids may be available for review or purchase. In some cases, you may be able to look over or obtain photocopies of these resources at local NCFS county ranger offices. Another useful planning aid is the online Forestry Preharvest Planning Tool (FPPT) managed by NCFS. This tool allows users to view and create customized maps for any area in North Carolina. The FPPT is available at: https://www.ncmhtd.com/NCFS/FPPT/fppt/Index.aspx

On Site Examination

The best resource for planning is an on-the-ground examination of the site. This allows you a chance to see firsthand what the site is like and where water quality or BMP issues need to be addressed.

Topographic Maps ('topo' maps)

These are detailed maps that indicate slope, land contours and estimated stream features. While topo maps provide good planning information, they are not always sufficiently accurate for forestry purposes, especially related to stream identification.

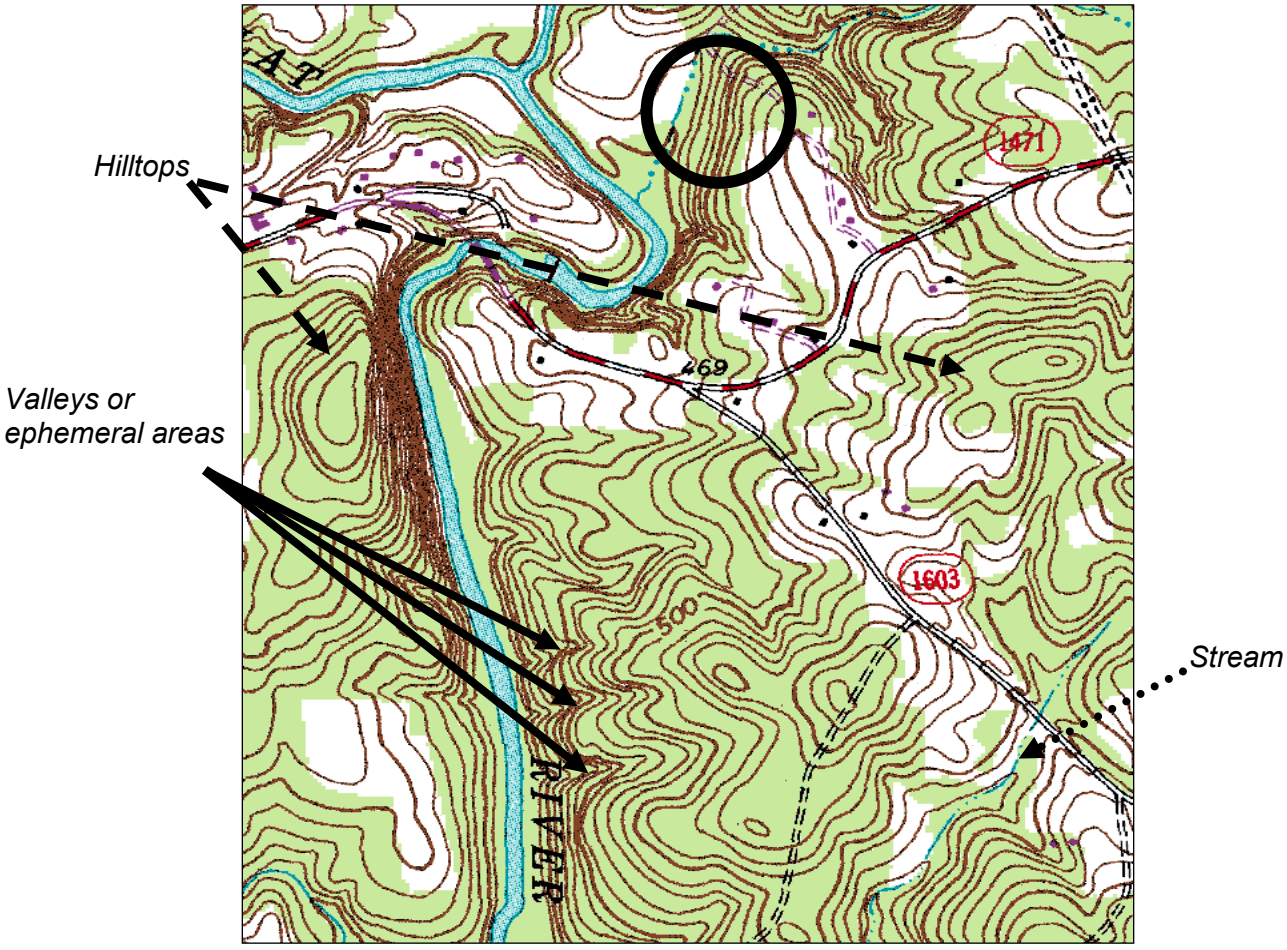


Figure 3C: Excerpt from the USGS 'Rougemont' 7.5-minute quad topo map

Picture note: *As contour lines get closer together, this indicates steeper slopes (circled). Complete circles of contour lines indicate the peaks of hilltops (dashed squares). Where contour lines are shaped like a V, this indicates gullies, or some form of water drainage on the land. Note that no streams are indicated in the three V-notched locations shown by solid arrows. Compare this topo map with the soil survey map on the next page. Streams are indicated by either a dashed / dotted line or a solid line. On color topo maps, these lines appear in blue color, which is why they are often called 'blueline' streams (shown by dotted arrow).*

Soil Surveys ('soil maps')

Soil survey maps are usually black and white, and provide details on the expected soil conditions of the site, along with estimated stream features.

Many of these surveys also provide generic recommendations on the operability of a soil type for heavy equipment use and forest growth.

While soil maps provide good planning information, they are not always sufficiently accurate for forestry purposes, especially related to stream location and identification. You should make an on-site examination to verify the features shown on the survey map.

Soil survey maps are a good way to determine whether any unique soil conditions exist on your site. Examples include organic, muck soils or shrink/swell clay soils, explained in Chapter 1.

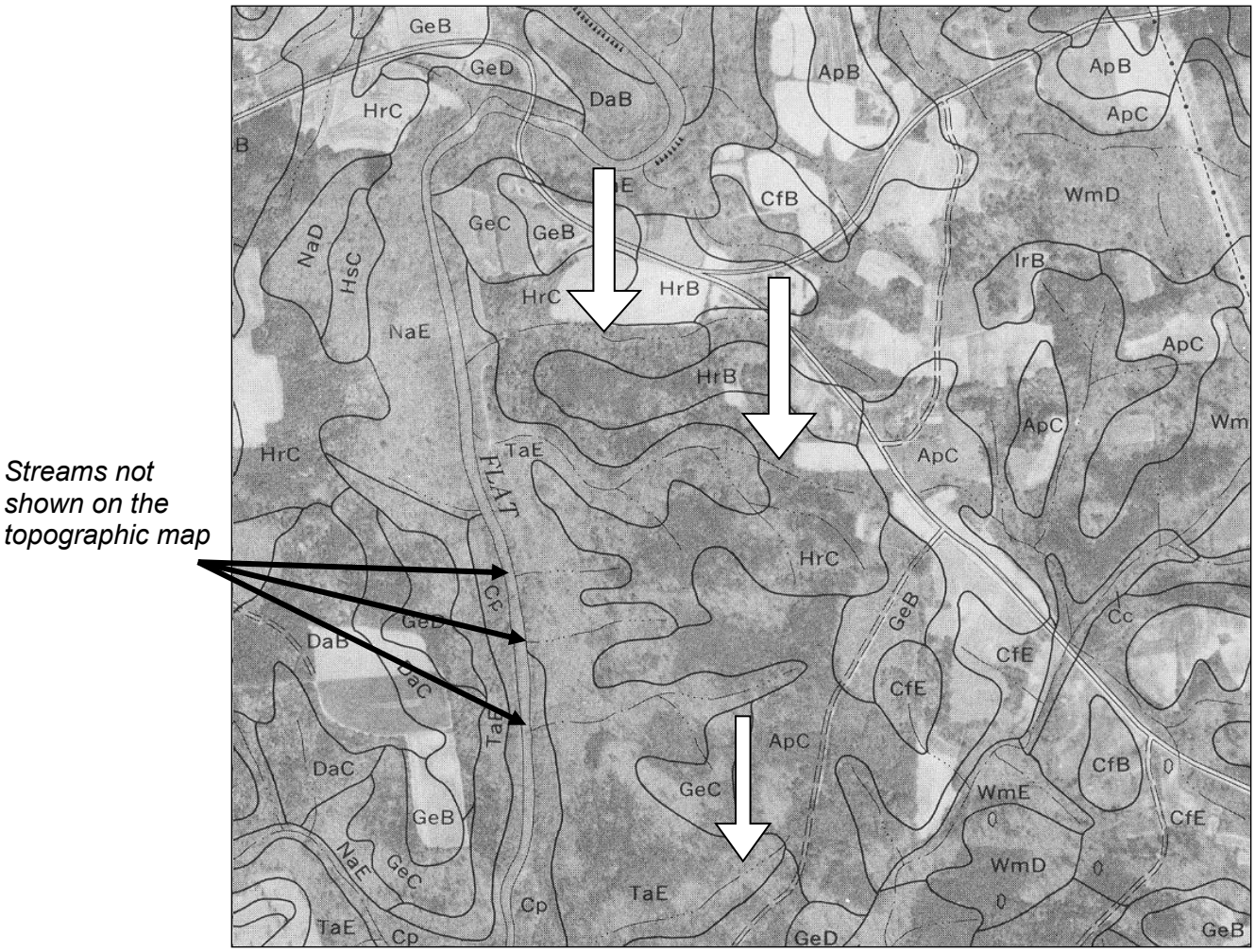


Figure 3D: Excerpt from NRCS soil survey map of the same location as shown in Figure 3C

Picture note: *Soil maps show public roads, and some woods- or field-roads. The alphabetic codes refer to the different soil types estimated for that location. Each code is explained in the soil survey book. Streams are indicated with dashed/dotted lines. On the topo map, the three V-notch areas along the Flat River did not indicate any streams. However, on the soil map, each V-notch is estimated to have a stream. Also note the other streams on the soil map, that are not indicated on the topo map (shown by white arrows).*

Figure 3E: Aerial photo of same Durham County location as shown in Figures 3C and 3D

Picture note: *This aerial photo shows the same location as the above two maps. Roads, rivers, forest edges, and major corridors are easy to see on a photo, but small individual streams are not. Looking carefully, you may notice differences of shadowing in the area of the three V-notches along the Flat River. Shadowing like this may be your only clue on a photo that a stream or gully exists. A 'ground-truth' on-site examination will help verify exactly what stream and ground conditions exist.*

<<< Helpful Hint >>> It is the responsibility of the landowner to verify and locate property lines. Do not rely on the logger, forester, or timber buyer to do it. Only a Registered Land Surveyor can **establish** property lines.

Tax Parcel Information (tax maps)

County tax offices may have tax parcel information that can help identify the general vicinity of a site's property boundary lines.

<<< Helpful Hint>>> Tax maps are only a general approximation and do not provide the same high level of detail or accuracy as a surveyor's property line survey plat.

>>> Remember that a goal without a plan is just a wish! <<<

>>> The 6P's of Planning <<<

[1]Proper [2] Prior [3]Planning [4]Prevents [5]Poor [6]Performance!

Chapter 4: Streamside Management Zones (SMZs)

A streamside management zone (SMZ) is an area along both sides of intermittent streams and perennial streams and along the margins of perennial waterbodies where extra precaution is used in carrying out forestry-related, land-disturbing activities in order to protect water quality. Think of the SMZ as the 'last line of defense' to prevent sediment and other pollution from entering the water. In addition to SMZs, other BMPs should be implemented to minimize the risk of overwhelming the SMZ's capacity.

The SMZ can help achieve multiple water quality protection goals:

-- Slowing and filtering runoff.
-- Capturing sediment.
-- Providing shade from sunlight intensity.
-- Maintaining streambank stability.
-- Reducing impacts from nonpoint source pollution.
-- Sustaining aquatic habitat conditions.

Part 1 -- Factors Influencing the Application of SMZs

Although water quality is the focus of the BMPs in this manual, SMZs are multi-functional and can often help to achieve other goals such as wildlife habitat, seed sources for regeneration, windscreens, and aesthetics. In those situations, alternative layouts and silvicultural prescriptions for the SMZ may be appropriate to accomplish multiple objectives.

Slope

Steeper and longer slopes have higher soil erosion potential and may require a wider SMZ or additional BMPs to slow down and capture runoff.

Soils

Some soils are more likely to erode than others. On soils more prone to erosion, a wider SMZ or additional BMPs may be needed to prevent visible sediment from entering the stream. The USDA-NRCS soil survey or local assistance can help to estimate the erosion potential of a soil.

Vegetation and Groundcover

Protecting, maintaining, and/or establishing vegetation and/or ground cover within the SMZ is vital to confine visible sediment and restrain accelerated erosion. If the SMZ has sparse groundcover vegetation, then a wider SMZ or additional BMPs may be needed.

Special Waters Designation

Some streams and waterbodies have a special designation such as Water Supply, Wild/Natural/Scenic, Trout, or Critical Habitat (see Table 2-1 for other examples). A wider SMZ, alternative prescriptions, and/or additional BMPs may be appropriate in those situations.

Part 2 -- Overview of Rules Related to SMZs and Riparian Buffers

Forest Practices Guidelines Related to Water Quality (FPGs)

A Streamside Management Zone (SMZ) **must be** established and maintained along **any** intermittent stream, **any** perennial stream, and along the margins of **any** perennial waterbody. It does not matter if that stream or waterbody appears on a map.

The statewide FPG rules require the following for all SMZs:

- ✓ Confine visible sediment resulting from accelerated erosion.
- ✓ Restrain accelerated erosion with groundcover or other BMPs.
- ✓ Do not install log decks, portable mills, roads, or skid trails in the SMZ (unless no option exists).
- ✓ On natural perennial streams, retain sufficient shade to protect those streams from temperature fluctuations that result in a violation of North Carolina's water quality standards.

For the purposes of FPG compliance, the SMZ can be whatever width is sufficient to achieve all of the FPG standards (reference 02 NCAC 60C .0201 through .0209).

River basin and Watershed Riparian Buffer Rules

The riparian buffer rules are not the same as SMZs. The riparian buffer rules apply in certain river basins and watersheds of North Carolina and limit forestry operations within a defined riparian zone. These rules are enforced by the NCDEQ-Div. of Water Resources (DWR); see Ch. 2 and Appendix 10.

The riparian buffer rules:

- …are ***in addition to*** the SMZs, on designated subject streams.
- …do not replace or supersede the FPGs; both sets of rules must be followed, where needed.
- …require a fixed-width buffer rule zone. Depending on which rule applies to that stream, that zone is either a 50-foot or 100-foot wide buffer.
- …restrict which trees can and cannot be harvested from the buffer rule zone, including diameter limits and locations within the buffer rule zone.
- …have eligibility requirements to be allowed to selectively cut timber from Zone 1 of the buffer.

Carefully review the appropriate NCFS *Forestry Leaflet* for the forest harvesting requirements of each riparian buffer rule. These rules may change, so make sure you understand the most recent version of the buffer rule. The NCFS can assist by making on-site stream determinations of which streams are subject to the buffer rules. Contact the appropriate District Office.

A Note on Beaver Ponds:

Streamside Management Zones (SMZs) as defined under FPG .0201 are not required around beaver ponds:

- However, visible sediment must still be restrained from entering the beaver pond, and accelerated erosion must still be prevented.

The DWR river basin and watershed 'riparian buffer rules' are required alongside the margins of beaver ponds/beaver impoundments:

- The buffer rule zone must be established along the water's edge, even if there is standing timber in the beaver impoundment area.
- Consult with DWR if you wish to breach the beaver dam and allow the stream to reestablish itself before implementing the buffer rule zone.

Part 3 -- Recommendations for SMZs

Recent forestry studies that were reviewed for this BMP manual are listed in Appendix 9 (online only). For site-specific decision-making, consider reviewing the research to tailor the SMZ widths and management prescriptions based on relevant study findings, site characteristics, and landowner objectives. A guiding principle for the following BMP recommendations is to 'keep it simple', with the idea being that if a BMP is relatively easy to implement, then it is more likely to be used.

BMPs for All SMZs

- Establish a SMZ along intermittent streams, perennial streams, and the margins of perennial waterbodies. (This is required by rule FPG .0201).
- The SMZ should wrap around the origin/head of the intermittent or perennial stream, extending into the ephemeral transition area; see Figure 4A.
- Minimize SMZ soil disturbance such as rutting, compacting, gouging, scraping, etc.
- Promptly reestablish removed/lost groundcover within the SMZ.
- Keep roads, trails, firelines and decks outside of SMZs. If these features must enter the SMZ, then keep heavy equipment machines at least 10 feet from the edge of the waterway and deploy more BMPs where needed.
- Conduct machinery refueling and routine servicing outside of the SMZ.
- Mix/load/unload pesticide, fertilizer, or other chemicals outside of the SMZ.

BMPs for SMZ Width

- Generally, a 50-foot wide SMZ (on each side of the stream) has shown to be effective in most cases to control nonpoint source pollution and maintain stream water temperature, while also providing other beneficial ecological functions.
- In any situation the SMZ should be no less than 20 feet wide (on each side).
- SMZ width can be measured atop and along the ground, starting at the edge of the streambank.

Situations Where a SMZ Wider than 50 Feet May Be Appropriate:

- Very steep slopes lead down to the SMZ.
- Multiple ephemeral streams converge close to, and drain toward, the SMZ.
- The ephemeral stream leading into the SMZ has evidence of recent channel scouring.
- Exposed, erodible or disturbed soils are nearby, including old erosion gullies.
- Lack of abundant groundcover/vegetation in the SMZ.
- Streambanks are slumping, undercutting, eroding or washing away.
- The SMZ is along a special-designated sensitive waterway (See Table 2-1 and Ch. 2-Part 4).
- There is a local history of, concern for, or enhanced risk of timber windthrow or blow-down in the SMZ (such as: tall trees with large crowns; trees on saturated soil; shallow-rooted trees; and/or site is located along the coastal fringe).

Situations Where a SMZ Narrower than 50 Feet May Be Acceptable:

- The SMZ is mostly flat ground, and flat terrain extends outwards from it for a long distance.
- Soil in the SMZ is dry, stable, un-disturbed, and has abundant groundcover vegetation.
- The SMZ contains mostly small-sized trees that can handle strong winds.
- The adjacent stand of timber on both sides of the SMZ retains a relatively high number of tree density spacing (ex: an un-cut stand; plantation thinning; selective harvest; etc.)

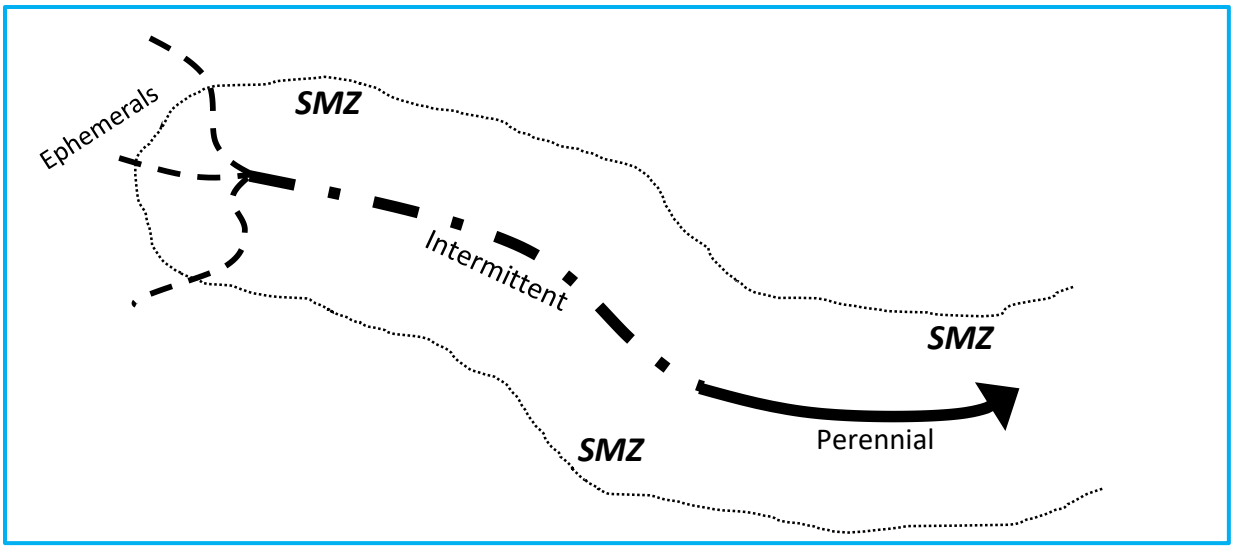


Figure 4A: Illustration showing the SMZ wrapping around the origin/head of an intermittent stream to include the ephemeral transition area

BMPs for Harvesting Timber in the SMZ

- Remove no more than 50% of the basal area (BA) in the SMZ.
  - EXCEPTIONS: Harvest of more than 50% BA may occur in any of these three scenarios:
    (1) Salvaging damaged timber from the SMZ.
    (2) Controlling or removing exotic / invasive / non-native plants in the SMZ.
    (3) Removing planted pines from the SMZ to allow regeneration of other more-suitable riparian tree species, thereby enhancing plant diversity in the SMZ.

  In each scenario, measures are needed to promote infiltration of runoff into the soil; and for perennial streams, to retain enough shade-producing canopy cover to avoid full sun exposure.
- Avoid creating gaps wider than 1 tree-length within the SMZ. Ideally, remaining trees would be evenly spaced apart.
- Fell timber away from the SMZ and stream when possible and safe to do so.
- Stabilize bare soil and repair soil gouges in the SMZ created by the felling and removal of trees.
- Do not use the SMZ as a de-limbing gate.
- If the site is prone to windstorms, consider alternative harvesting prescriptions to minimize the potential of trees blowing over and obstructing the waterway while still providing adequate shade over perennial streams and meeting the FPG standards.

<< Helpful Hint >> Retaining a minimally disturbed or even an undisturbed SMZ may be worthwhile if it aligns with the landowner's objectives and/or if there is little timber value in the SMZ. The fundamental purpose of a SMZ is to protect water quality by minimizing disturbance.

BMPs for SMZs during Site Prep, TSI and Forest Management

- Do not mechanically site prep, remove stumps, or push soil/debris within the SMZ.
- Avoid applying pesticide or fertilizer directly upon the water or into the stream channel.
- When doing prescribed burns, consider using the stream as a natural firebreak to avoid installing a plowed or bladed fireline. If a fireline is needed in the SMZ, install with hand tools.

<< Helpful Hint >> See Chapter 9 for more BMPs on forest management and site prep.
Be aware of possible residual effects of soil-active herbicide that may impact SMZ vegetation.

Figure 4B: SMZ on a timber harvest on rolling terrain

Picture note: *Residual trees and relatively undisturbed conditions in the SMZ provide shade and filter pollutants from the forest operation. If the stream channel is actively eroding as shown here, then a wider SMZ may be appropriate. The key objective of the SMZ is to protect the stream corridor.*

Figure 4C: SMZ on a timber harvest on flat terrain

Picture note: *Vegetation is relatively undisturbed with very limited timber harvested, which maintains stable soil and shade adjacent to the stream.*

Figure 4D: Aerial view of a SMZ on a 30-acre clearcut timber harvest

Picture note: *Note how the primary skid trail went around the SMZ, therefore no stream crossing was needed. The log deck was placed well away from the SMZ, and no log road construction was needed in the harvest area. This is a good example of preharvest planning and incorporating BMPs into harvest logistics.*

Part 4 -- BMPs for Ditches and Ephemeral Streams

Hydrologically-Connected Ditches

In this manual, a hydrologically-connected ditch means those ditches that have an immediate or eventual outlet to a stream.

<< Helpful Hint >> A modified natural stream (channelized stream) may look like a ditch, but is still considered to be a "stream" and therefore requires protection. If in doubt, seek assistance to help determine if a waterway is a ditch or a stream.

BMPs for Hydrologically-Connected Ditches

- Minimize nonpoint source pollution produced by forestry operations from being transported by these ditches into intermittent streams, perennial streams, or perennial waterbodies.
- Maintain structural integrity of the ditchbank.
- Maintain vegetation along the ditchbanks to manage erosion and sedimentation.
- Avoid obstructing water flow within the ditch.
- Do not service or re-fuel equipment next to the ditch, where possible.
- Do not mix/load/unload pesticide, fertilizer or other chemicals next to the ditch, where possible.

<< Helpful Hint >> See Chapter 8, Part 8, for BMPs for Ditch Maintenance.

Ephemeral Streams

In this manual, an ephemeral stream refers to the definition used in the FPGs.

BMPs for Ephemeral Streams

- Minimize nonpoint source pollution produced by forestry operations from being transported by ephemerals into intermittent streams, perennial streams, or perennial waterbodies.
- When establishing a SMZ on intermittent or perennial streams, the SMZ should wrap around the origin/head of that stream, where the ephemeral transitions into the stream's channel (Fig.4A).
- Minimize disturbance to the soil and groundcover within the ephemeral area. This includes roads, skid trails, log decks, portable mills and firelines.
- Maintain surface groundcover and woody debris accumulations within the ephemeral if material already exists in place; and as long as water will not back up onto another person's property.
- Do not service or re-fuel equipment within or next to the ephemeral stream, where possible.
- Do not mix/load/unload pesticide, fertilizer or other chemicals within or next to the ephemeral stream, where possible.

<< Helpful Hint >> Some of these recommendations may also be helpful for managing old legacy erosion gullies that could deliver runoff into a stream or waterbody.

Figure 4E: Ephemeral area protected during logging

***Picture note**: The SMZ on this site was wrapped around the main channel where the ephemeral area transitions into an intermittent stream. Soil disturbance was minimized on-site and within the SMZ. About 50% of the canopy cover was harvested from parts of this SMZ.*

A Note on Braided Streams and Oxbows

Braided streams and oxbows present increased operational challenges to protect water quality and conserve the soil. These features are best identified during normal water levels, so as to avoid overlooking them during dry times or when flooded. Minimizing overall disturbance/harvest along these features may be a preferred alternative. It is likely that the stream or river frequently connects with its floodplain in these areas during high-water flow. Therefore, extra precautions are warranted to limit overall soil disturbance, protect streambank stability, avoid streamflow obstruction, and provide effective erosion and sedimentation control.

Chapter 5: BMPs to Control Runoff and Capture Sediment

The term 'runoff' refers to water flow atop the ground surface that is not confined within a channel. The primary goal of BMPs for this topic are to minimize accelerated soil erosion by controlling the speed and volume of runoff. Along with controlling runoff, it is important to capture sediment before it enters a stream or waterbody.

The BMPs in this chapter can be applied to haul roads, decks, skid trails, stream crossings and firelines. Installing BMPs is best during initial construction. However, they can be successfully retrofitted with proper equipment and techniques.

More frequent implementation of BMPs may be necessary on steeper slopes, slopes with higher runoff and soils with more erosion risk. The spacing of BMP control structures is influenced by:

- Anticipated weather events until bare soil can be stabilized
- Road or trail steepness and drainage area contributing to runoff
- Soil erodibility

Implementing BMPs correctly can add value to the forestland for its owner and to those who benefit from the land or its resources. Conversely, incorrect implementation or insufficient amounts of BMPs may lead to prolonged and substantial erosion and water quality problems that will be costlier to repair than it would have taken to prevent them in the first place.

Part 1 -- BMPs to Control Runoff

Broad-based Dip

A broad-based dip is a combination of a shallow depression (dip) excavated into the road surface with a slight hump at a reversed grade, formed immediately on the downhill edge of this dip. An outlet area is provided for the runoff to leave the roadway. The dip works by diverting runoff from the road's surface and through the outlet. The hump acts as a barrier to continued runoff flow downhill on the road.

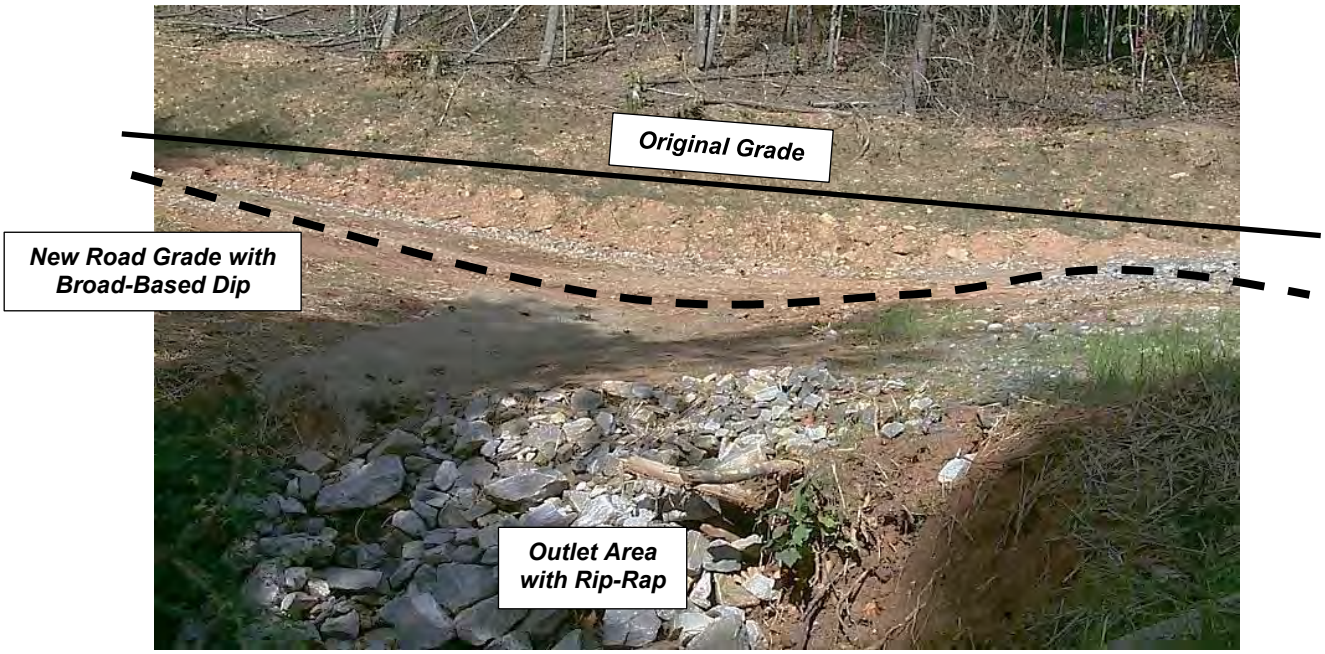


Figure 5A: Cross-section view of a broad-based dip and outlet

Table 5-1: Recommended Spacing of Broad-Based Dips by Slope Grade.

Slope Grade (*percent*)	Broad-based dips (*feet*)*	**The spacing ranges are only general guidelines and should be adjusted according to your specific site, soil, groundcover, equipment or other conditions.*
8 to 12	150 to 135	
4 to 7	200 to 155	
0 to 3	300 to 235	

BMPs for Broad-Based Dip

- Lay out and construct the broad-based dip at right angle to the travel surface and across the full width of the road.
- Excavate a shallow dip approximately 15 to 20 feet long into the uphill travel surface.
- Construct and compact a slight hump across the downhill edge of the dip using the native soil when possible. The reverse grade of the hump should not exceed 3% slope downward to base of the dip.
- Outslope the bottom of the dip at enough of an angle to turn away water and runoff, but generally no more than a 3% outslope angle.
- On slopes greater than 8%, or when needed, hardening the travel surface of the broad-based dip with stone or other materials can prevent erosion and improve vehicle traction.
- Situate the broad-based dip outlet in a manner that prevents runoff from flowing directly into streams or waterbodies. Take measures to capture the sediment from the outlet as needed.
- Avoid siting the outlet onto soft soil or fill material, unless measures are implemented to prevent accelerated erosion from the outlet.
- Avoid using broad-based dips to provide drainage for inside ditchlines or groundwater seeps. Use cross-drains instead.

Waterbar

A waterbar can be thought of as an angled 'speed bump' with a shallow trench along the uphill edge that diverts runoff. Waterbars are typically used when closing off or 'retiring' skid trails and roads. They are not just soil piled in the road surface. There are two key points to functional waterbars:

1. **A waterbar must be constructed to extend completely across the trail or road surface:**
   - This prevents runoff from moving around the ends of the waterbar and flowing past it.
   - This may require 'tying-in' the waterbar with adjacent side / cut slopes.
   - This may require extending the waterbar beyond the width of the road or trail travel surface.
2. **The waterbar should be angled and have a suitable outlet for diverting runoff into an area where sediment can settle and/or filter out (see Part 2 -- BMPs for Capturing Sediment). It is not intended as a trap to block or pool runoff.**
   - Proper angling is needed to allow the runoff to drain and not backup.
   - Excavation of a shallow trench along the uphill edge of the waterbar hump helps collect and drain off the diverted water.

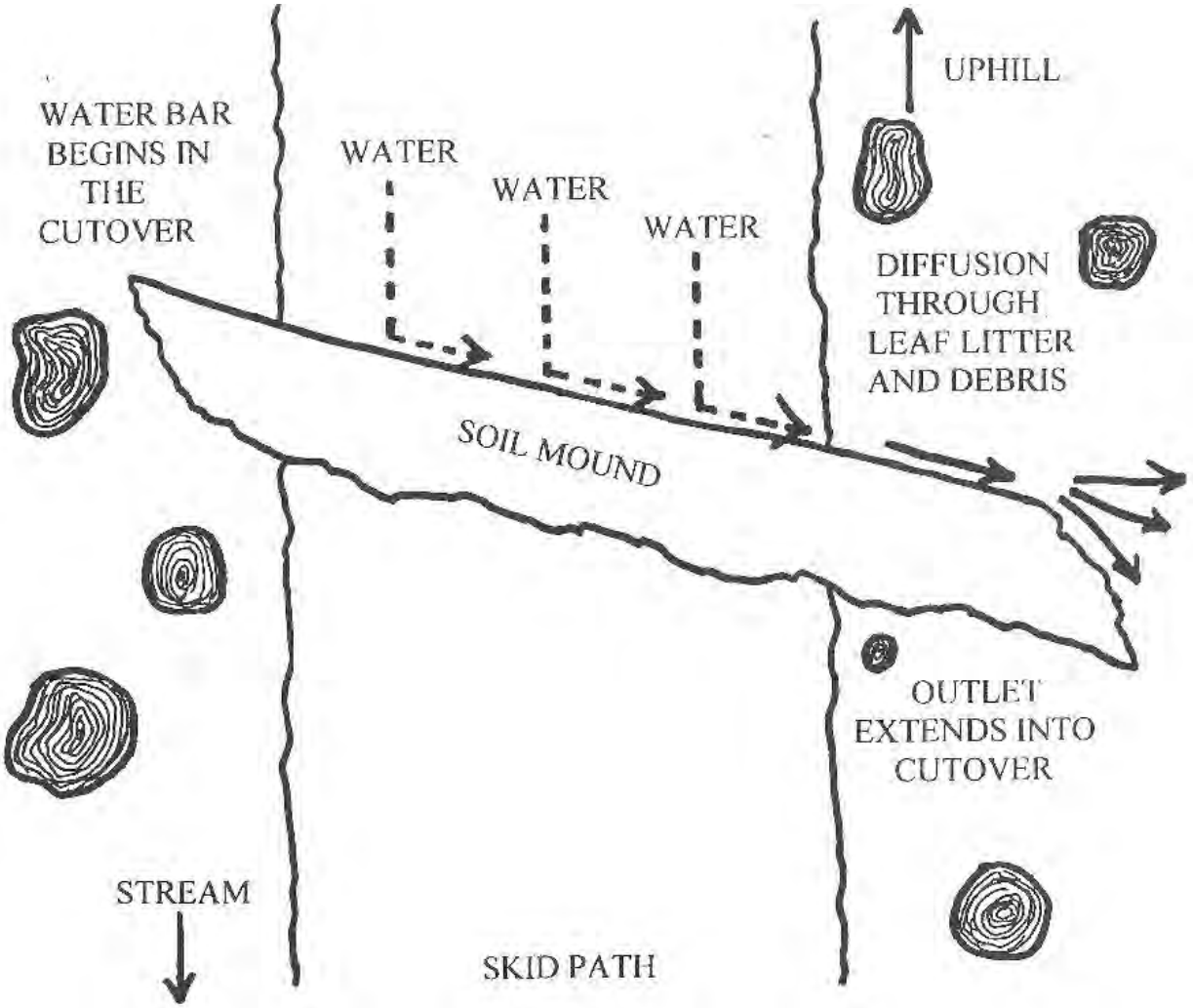


Figure 5B: Overhead view sketch of an idealized waterbar installation

Picture note: *The outlet should be pushed out so that water has a clear exit. The water should not concentrate and create a flow path through the cutover to the stream and water should not pond at the end of the waterbar or come back around into the skid trail.*

Table 5-2: Recommended Spacing of Waterbars by Slope Grade.

Slope Grade (*percent*)	**Waterbars** (*feet*)*	**The spacing ranges are only general guidelines and should be adjusted according to your specific site, soil, groundcover, equipment or other conditions.*
20 +	40 to 30	
16 to 20	60 to 40	
11 to 15	80 to 60	
6 to 10	100 to 80	
0 to 5	120+ to 100	

BMPs for Waterbars

- When building waterbars next to a side / cut slope, tie the uphill end of the waterbar into the side / cut slope, and angle the waterbar downhill toward the outfall edge of the road or skid trail.
- Use an angle ranging from 15 to 30 degrees (downslope) for the waterbar to properly drain while preventing pooling of runoff behind it.
- Excavate the trench with enough gradient to allow adequate flow of water runoff, generally not to exceed 2% to 3%.
- Prevent runoff from directly entering into streams or waterbodies. Capture sediment at the outlet.
- Avoid having the outlet on soft soil or fill material, unless measures are implemented to prevent accelerated erosion from the outlet's runoff.
- Establish groundcover or harden the waterbar if needed to maintain long-term function.
- Avoid driving over waterbars when completed. Traffic will reduce their functionality.

Figure 5C: Waterbar constructed across a skid trail

Picture note: *The waterbar shown here is properly angled diagonally across the skid trail, to allow runoff to flow off the surface. A shallow trench can carry the runoff. This waterbar extends past the edge of the skid trail to prevent passage of runoff around the waterbar hump.*

Figure 5D: View of the trench along the uphill face of the same waterbar

Picture note: *The trench that is excavated along the uphill face of the waterbar, pictured left, allows water to flow off the trail surface and through the outlet. This outlet extends into a well-vegetated area that provides good infiltration and sediment capturing effectiveness. Be sure to minimize any curvature of the waterbar across the road or trail. The waterbar shown here would be best if it were a little less curved, but it appears that it should function satisfactorily.*

Rolling Dip

A rolling dip is a cross between a waterbar and a broad-based dip. Like broad-based dips, they have a reverse grade, formed immediately on the downhill edge of the dip. However, this reverse grade is generally shorter, and the outlet is narrower. Like waterbars, they have a mound of dirt at the downhill end that is angled to divert runoff. Rolling dips can be used on roads with steeper grades that are unsuitable for a broad-based dip.

Figure 5E: A rolling dip on a forest haul road

Picture note: *This rolling dip was constructed on a haul road and the area immediately beyond the travelway is vegetated area to further control erosion.*

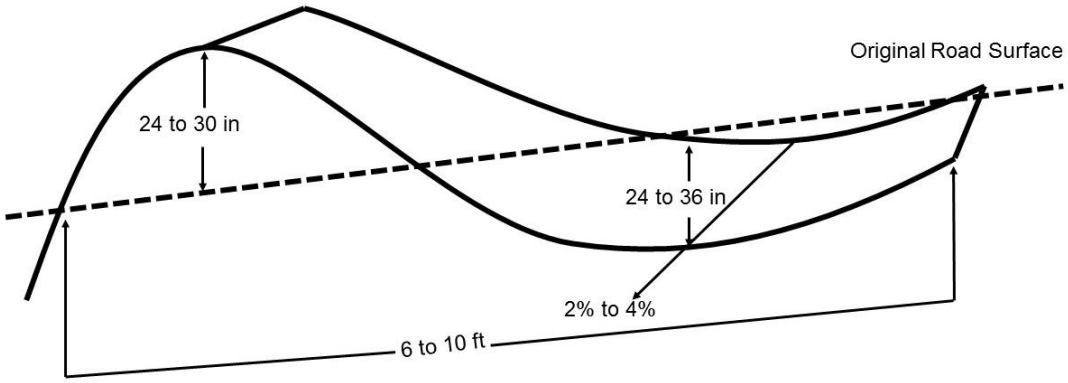


Figure 5F: An idealized schematic of a rolling dip.

Table 5-3: Recommended Spacing of Rolling Dips by Slope Grade.

Slope Grade (*percent*)	**Rolling Dips** (*feet*)*	**The spacing ranges are only general guidelines and should be adjusted according to your specific site, soil, groundcover, equipment or other conditions.*
16 +	120	
11 to 15	135	
6 to 10	150	
0 to 5	180	

BMPs for Rolling Dips

- Rolling dips should be excavated and constructed using equipment and/or techniques that assure proper angles and a firm waterbar-like hump.
- A 10 to 15-foot long, 3% to 8% reverse grade should be constructed into the roadbed by cutting up-grade to the dip location and then using the cut material to build the mound for the reverse grade.

Turnout

A turnout is a type of shallow trench or pathway that diverts runoff from the surface of a road, skid trail or fireline. There are two angles on a turnout. First, the outlet gradient angle, which is the slope need to drain runoff from the road surface. Second, the turnout angle, which is how wide apart the turnout veers away from the roadside or trail. A wing-ditch or lead-off ditch is a specific type of turnout used for controlling runoff within roadside ditches. In any case, the turnout should be constructed as a continuous offshoot of the road, skid trail, fireline or roadside ditch. This helps maintain an uninterrupted connection for runoff to flow.

BMPs for Turnouts

- Begin the inflow of the turnout at the same grade level as the road, skid trail, fireline or ditch so runoff can flow easily without being interrupted.
- Excavate the turnout with enough outlet gradient angle so runoff can drain in a controlled manner, generally from 1% to 3% is adequate.
- Construct using a turnout angle between 15 to 30 degrees downslope.
- Situate the end of the turnout outlet in a manner that prevents runoff from flowing directly into streams or waterbodies. Take measures to capture the sediment from the outlet as needed.
- Avoid siting the outlet onto soft soil or fill material, unless measures are implemented to prevent accelerated erosion from the outlet.
- For use in roadside ditches, take action to minimize erosion within that ditch so the inflow of the turnout does not create a gully.

Figure 5G: A turnout used together with a waterbar on a skid trail

Picture note: *This turnout was pushed out into a vegetated area so water can soak into the ground and sediment will settle out. Note the use of more waterbars further down the skid trail.*

Table 5-4: Recommended Spacing of Turnouts by Slope Grade.

Slope Grade (*percent*)	**Turnouts** (*feet*)*	
20 +	60 to 40	**The spacing ranges are only general guidelines and should be adjusted according to your specific site, soil, groundcover, equipment or other conditions.*
16 to 20	100 to 60	
11 to 15	140 to 100	
6 to 10	180 to 140	
0 to 5	250+ to 180	

Inside Ditchlines

An inside ditchline provides a place to collect runoff that comes off the surface of an insloped or crowned road. The ditchline carries this runoff for a short distance until a cross-drain moves the runoff from the inside edge (upslope side) to the outside edge (downslope side), where the runoff drains.

Inside ditchlines can be difficult to correctly construct and maintain. While BMPs are provided below, you are encouraged to consider the alternative of installing an outsloped road surface, which does not need inside ditchlines.

Figure 5H: A forest road with a shallow inside ditchline

BMPs for Inside Ditchlines

- Excavate the ditchline to the minimum depth and width needed to carry the expected runoff:
  -- The cross-sectional area within the ditchline should be matched to the cross-sectional area of the pipe to be used for cross-drainage (see Cross Drain BMPs on the next page).
  -- A conservative rule of thumb is to approximately match the ditchline cross sectional area to the same cross-sectional area as an 18-inch diameter pipe.
- Control runoff speed and volume to minimize erosion within the ditchline. Where appropriate, install geotextiles, matting, stone or other suitable material to reduce the potential for accelerated erosion.
- Install turnouts or cross-drains at intervals adequate to carry the expected runoff.
- Prevent the runoff from entering streams and waterbodies. Capture sediment from the outlets.
- Avoid placing on soft soil or fill material, unless measures are taken to prevent accelerated erosion.

Cross Drain

Cross-drains move water and runoff from one side of a road or trail to the other, usually under or through the roadbed. Cross-drains can carry runoff out of an inside ditchline; drain runoff along grades; provide drainage for groundwater seeps or springs; and/or direct runoff away from log decks.

Figure 5I: View of the inlet end of a cross-drain installed in a permanent forest road.
Picture note: *This cross-drain provides drainage of runoff that flows within the inside ditchline. Note the additional grass seed and rock stabilization BMPs.*

Table 5-5: Recommended Spacing of Cross Drains by Slope Grade

Slope Grade (*percent*)	**Turnouts** (*feet*)*	**The spacing ranges are only general guidelines and should be adjusted according to your specific site, soil, groundcover, equipment or other conditions*
20 +	60 to 40	
16 to 20	100 to 60	
11 to 15	140 to 100	
6 to 10	180 to 140	
0 to 5	250+ to 180	

BMPs for Cross-Drains

- The cross-sectional area of the pipe should be matched to the cross-sectional area of the ditchline.
- Use at least a 18-inch diameter pipe on heavy flow areas. Use at least a 15-inch diameter pipe if only needed for groundwater seeps or for locations with minimal runoff volume and/or debris.
- Cover culvert pipe with at least 1-foot of fill and harden the crossing to protect the pipe from traffic.
- Match the base level of the cross-drain inflow to the base elevation of the ditchline so runoff can flow into and through the cross-drain uninterrupted. Use a drop-inlet if the elevation of the cross-drain inlet is lower than the ditchline.
- Set cross-drains on a 2% to 4% downslope angle to provide good drainage and help prevent debris from clogging the drain.
- Install cross-drains at an angle suitable to allow free flow of runoff into and through the cross-drain.
- Minimize erosion on both ends of the cross-drain so the ditchline does not down-cut and create a gully or produce accelerated erosion.
- Where needed, harden the inflow headwall of the cross-drain with stone, sandbags, geotextiles, vegetation, drop-inlet, or other suitable materials to avoid headcutting or accelerated erosion.
- Situate the cross-drain outlet in a manner that prevents runoff from flowing directly into streams or waterbodies. Take action to capture the sediment below the outlet as needed.
- Avoid siting the outlet onto soft soil or fill material, unless measures are implemented to prevent accelerated erosion from the outlet.

Road Templates (Insloping, Outsloping and Crowning)

The degree to which a road surface is tilted or angled influences runoff. By insloping, outsloping or crowning a road surface, you are creating a tilt or angle that naturally moves water and runoff from the surface. If the terrain varies along the road, select a template that will best suit the situation. It is not necessary to keep the same road template throughout the entire road length.

BMPs for Insloping, Outsloping and Crowning

- On insloped roads, excavate and maintain inside ditchlines and cross-drains in order to carry runoff. Refer to the BMPs for inside ditchlines and cross-drains.
- For freshly graded outsloped or crowned roads, a temporary low berm along the outside (downslope side) edge of the road may prevent washing away of the soft soil and fill material.
    -- If a temporary berm is installed, provide outlets or gaps so runoff can move away from the road surface in a controlled manner. Consider applying BMPs to capture runoff (see BMPs to Capture Sediment).
- Maintain the road surface as needed to minimize or repair ruts, holes, or depressions that hold water, which can weaken the roadbed or create concentrated runoff with sediment transport.
- When possible, conduct grading operations when the road surface is moist. Fill ruts and potholes with gravel or compact fill as frequently as possible.
- Avoid widening the road or over-steepening fill slopes formed by blading the surface material off the road.

Figure 5J: Forest access road in the mountains

***Picture note**: The road is slightly crowned with an inside ditchline. Surface is stabilized with gravel. Brush cutting helps to daylight the road corridor. Road embankment is stable with vegetation.*

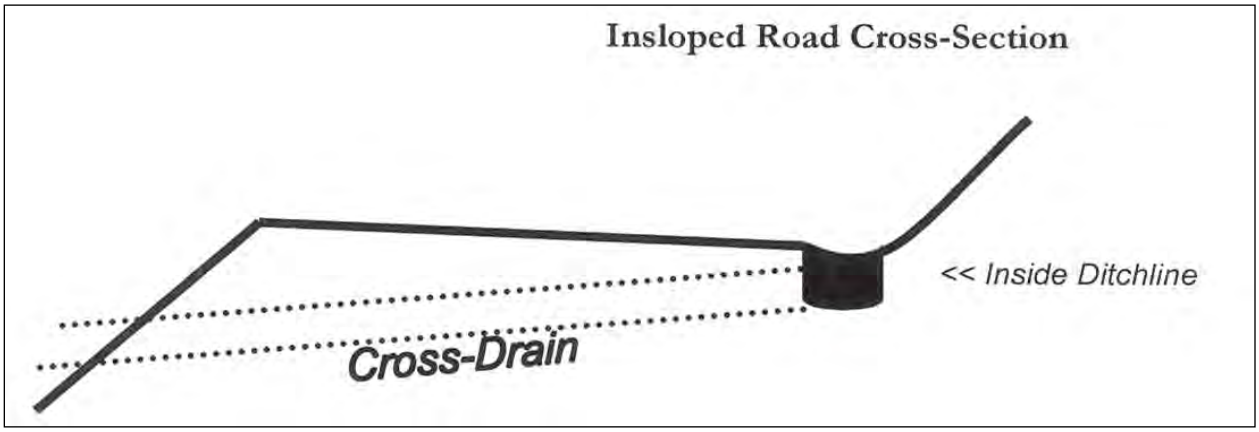


Figure 5K: Schematic cross-sectional sketch of insloped road surface profile

Insloping allows runoff to drain into an inside ditchline. Because the ditchline is between the uphill side/cut bank and the roadbed, the ditchline must be drained with a turnout or cross-drain.

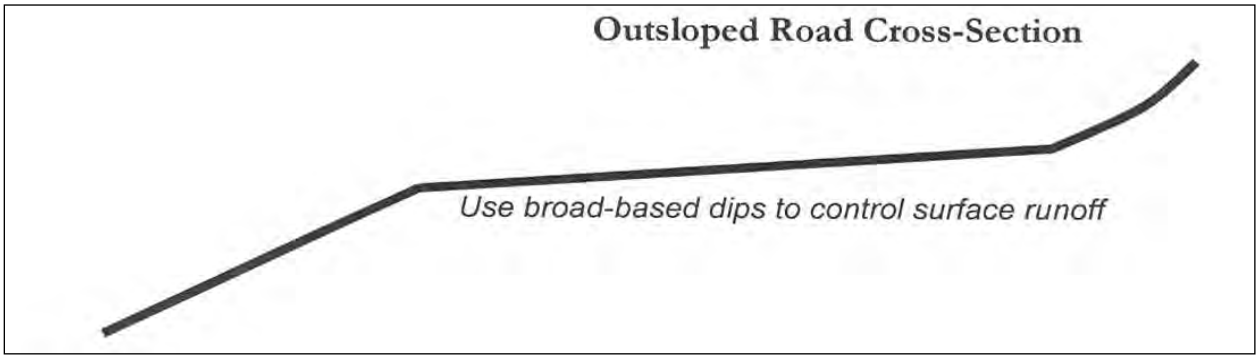


Figure 5L: Schematic cross-sectional sketch of outsloped road surface profile

Outsloping allows runoff to drain from the road surface toward the outside (downslope) edge of the road, where the runoff can be controlled or allowed to absorb into the adjacent ground.

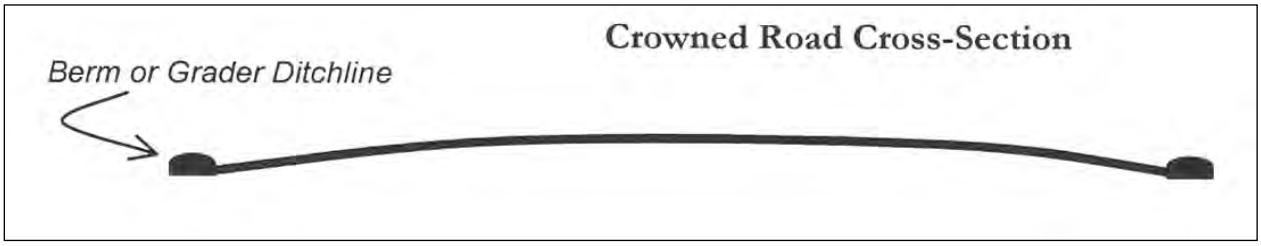


Figure 5M: Schematic cross-sectional sketch of crowned road surface profile

Crowning creates a slight hump across the road's cross section, by having the centerline of the road higher than both roadside edges. If a road is to be crowned, other BMPs to collect and/or capture runoff may be needed. Crowning is usually used on wider, permanent access roads or in flat lands with a ditch on at least one side to collect runoff.

Part 2 -- BMPs to Capture Sediment

Filter Areas

Filter areas are usually a long-term, low-cost option to capture, slow, and contain runoff so sediment and other potential pollution can settle out before reaching a waterbody. They can be differently shaped or sized, depending upon the application and needs of the soil and site.

BMPs for Filter Areas

- Permanent groundcover should be retained or established that allows runoff to slow down and soak into the soil:
  -- Natural, relatively undisturbed groundcover and/or vegetation is usually the best choice for a filter area.
  -- Established groundcover can also be effective, but may require additional BMPs and/or maintenance.
- Intensive soil disturbance should be minimized.
- Use stable, well-drained soils for filter areas when available.
  -- If unstable soils must be used for a filter area, install treatments such as erosion matting or other methods to stabilize the soil.

Sediment Traps or Pits

Sediment traps are excavated holes that trap and store runoff, and are usually installed where runoff is concentrated nearby streams and other waterbodies.

Traps or pits can be used for either temporary runoff control, or long-term installation. Permanent use of traps/pits will require more substantial construction and periodic maintenance.

BMPs for Sediment Traps or Pits

- Excavate the pit with a suitable opening and depth to capture the expected sediment runoff while minimizing soil disturbance to the adjacent area. Refer to Figure 5P for suggested sediment pit sizing dimensions.
- Locate the pit within stable, well-drained soils when available. If the pit must be situated within unstable soils, install additional measures to provide soil stabilization around the pit.
- Dispose or stabilize the excavated spoil material to keep it from washing away. Avoid using the spoil to build up the sides of the pit, since this loose spoil material can easily wash away or fall back into the pit.
- For sediment pit installations intended to be permanently functional:
  -- Create a reinforced outlet for overflow capacity that will reduce the likelihood of the pit walls being washed away or 'blown out'.
  -- Harden the walls of the pit to minimize the risk of structural failure.
  -- Revegetate exposed soil around the perimeter of the pit.
  -- Periodically clean out accumulated sediment. A useful rule is to remove and stabilize the accumulated sediment whenever the pit reaches half full.

Figure 5N: A functioning sediment pit excavated alongside a forest road
Picture note: *This sediment pit is located in a good position to capture sediment that flows off this graveled, outsloped road. The pit is positioned away from the stream (in background).*

Figure 5O: Temporary sediment capture alongside a forest road
Picture note: *This temporary holding area, reinforced with stone, is successfully capturing runoff and sediment. The stone provides good support and backing.*

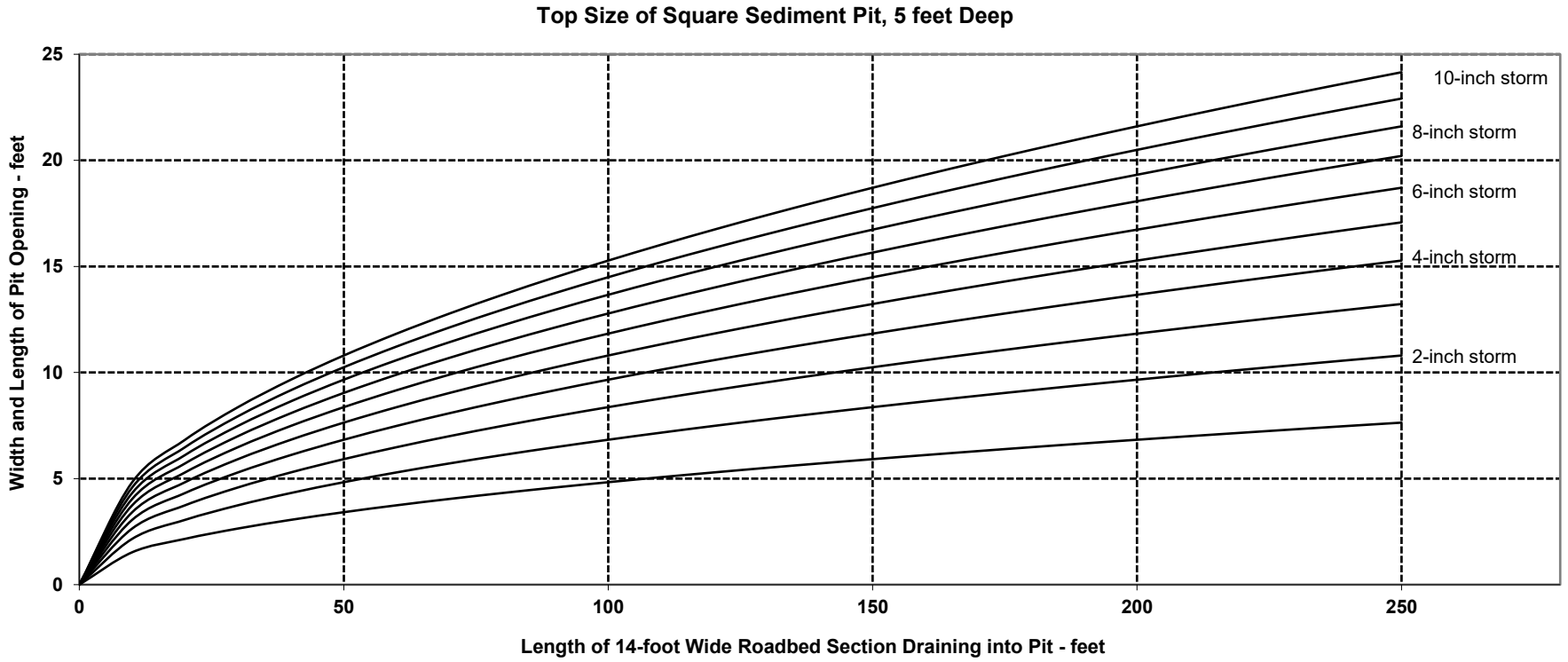


Figure 5P: Graph for Estimating the Area of Sediment Traps and Pits by Storm Size for a 14-ft. Wide Road (assumes 5-ft. depth)

How to read the graph: If you have a 50-foot long stretch of roadbed that is 14-feet wide, and you wish to capture a "4-inch storm" volume, you would need a sediment pit with dimensions of ***at least*** 5 feet deep x 7 feet wide x 7 feet long.

The calculations used to create this graph make the following assumptions, which may or may not apply to your forestry application:

- The sediment pit is 5 feet deep and the roadbed is 14-feet wide;
- The roadbed and inside ditchline are nearly impervious and all runoff from the road section enters the pit;
- No allowance is provided for deposited sediment that may be included within the storm's water runoff. A larger dimension pit would be needed to accommodate the water runoff *and* sediment.

Source: Dr. Lloyd W. Swift, Jr. (ret.) Coweeta Hydrologic Laboratory, Southern Research Station, USDA-Forest Service. 2006.

Silt Fence

Silt fence is a geotextile or fabric that is supported with stakes, with the bottom partially buried into the ground and is for temporarily capturing runoff. Use of a silt fence is most effective for temporarily capturing sediment and delaying runoff across the ground surface, before reaching a channel or forming gullies and erosion trenches in the land. **However, silt fence cannot effectively capture mass movement of sediment or capture runoff for an extended period of time.**

Silt fencing may be useful to capture sediment in areas of exposed bare soil until vegetation can be established. Due to the natural roughness and uneven terrain on forestry job sites, a silt fence can be very difficult to correctly install and still remain effective.

BMPs for Silt Fence

- Additional measures upslope and downslope of the silt fence may be required to slow, control and capture sediment.
  -- If there is considerable sediment piling up behind the silt fence, determine the sediment source and adjust or add BMPs accordingly.
- The suggested drainage area limit is 100 feet of fence for every one-quarter acre of land. Refer to Table 5-6 below for further reference.
- Set fencing along the land contours and extend the fencing far beyond the expected pathway(s) of runoff flow. The ends of the fencing should be gently turned like a sideways 'J', with the hook facing uphill.
- Bury the bottom 4 to 6 inches of silt fence securely into the ground to keep runoff from flowing underneath:
  -- Install the fence so that the buried portion is along the upslope face of the fence, to prevent the fence from getting washed over by sediment.
- Adequately reinforce the silt fencing from being knocked over or blown out. Wire fencing backer or additional staking can be used.
- Frequently monitor the silt fence after installation. Promptly take action to maintain or improve the filtering effectiveness.

Table 5-6: Recommended Applications for Every 100 feet of Silt Fence.

Slope Grade… (percent)	…Between Fence-rows (feet)	Area (acres)
0 to 2	100	0.23
2 to 5	75	0.17
5 to 10	50	0.11
10 to 20	25	0.06
20 +	15	0.03

Adapted from N.C. Division of Energy, Mineral and Land Resources' Erosion and Sediment Control Handbook Practice Standards and Specifications.

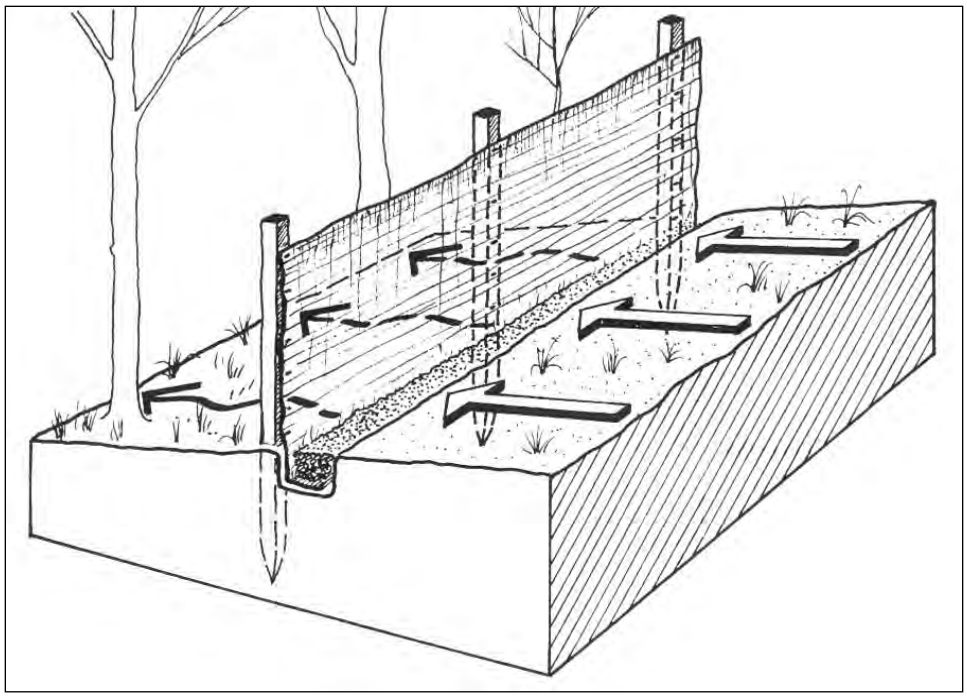


Figure 5Q: Sketch of properly installed silt fence

***Picture note**: This sketch depicts the proper installation of silt fence. Note the bottom of the silt fence along the upslope side is buried into the soil, and the fence is securely staked. Consider setting multiple rows of fencing to provide additional protection. Avoid using silt fence to divert water. It should be used only as a temporary sediment filter. Consider metal t-posts when wooden stakes will not provide enough support. (Illustration provided courtesy of Maine Forest Service).*

Figure 5R: Silt fence supported with metal T-posts

Straw Bales

Straw bales, or a bale of other natural fibers, can be a low-cost and effective tool to slow runoff and capture sediment. Bales often are better than silt fence or brush barriers since they can conform better to the ground surface. Bales can be placed around the perimeter of an area with exposed soil, or across the pathway of runoff flow. The bales will help control the runoff, and act as a sediment filter. However, since they are natural fibers, the bales will eventually decompose and breakdown. As a result, they should be used for temporary runoff capture and control.

Places where bales may be helpful:

- Near outlets of BMPs to control runoff described in Part 1
- Stream crossing approachways
- Alongside freshly graded outsloped roads
- Around edges of log decks
- Supporting or supplementing silt fence installations

BMPs for Straw Bales

- Additional measures upslope and downslope of the bales may be needed to slow, control and/or capture sediment.
  -- If there is considerable sediment piling up behind the bales, determine the sediment source and adjust your BMPs accordingly.
- Set bales tightly against the ground surface and anchor the bales firmly into the soil if the bales are likely to wash away.
- If square bales must be stacked, stagger the joints between bales so they do not line up over the joints in the previous layer, similar to brick laying.
- Frequently monitor bales after installation. Promptly take action to maintain or improve effectiveness.

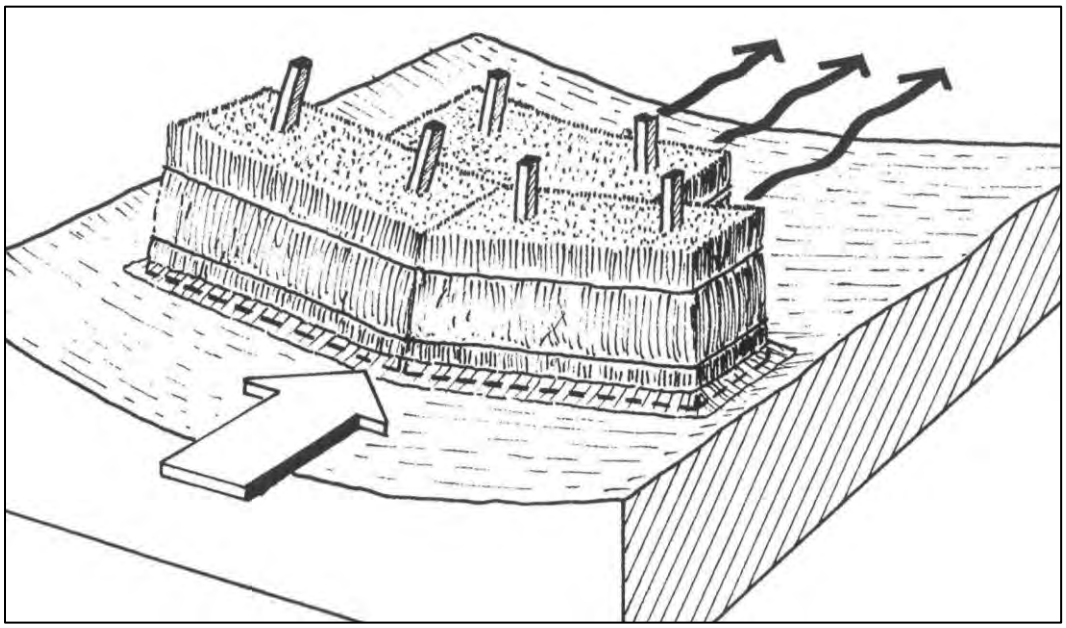


Figure 5S: Sketch of bales used to capture sediment

Picture note: *When bales are used to capture sediment, you should make sure that (1) the bottom of the bales conforms to the ground surface to prevent leakage, (2) bales are secured if needed to prevent them from being washed away, and (3) joints between bales are staggered like bricks. Illustration provided courtesy of Maine Forest Service.*

Brush Barriers

Brush barriers are piles of leftover, unusable tree and vegetation debris that is carefully piled and packed down to act as a temporary filter barrier to slow runoff and capture sediment. Creating brush barriers is a productive use and disposal for debris that is generated by road or skid trail construction and can be a low-cost method of temporary sediment capture. Places where brush barriers may be helpful:

- Alongside newly constructed or graded roads
- Alongside and on top of skid trails
- Around edges of log decks
- Stream crossing approaches

Figure 5T: A brush barrier alongside a retired logging road

Picture note: *The brush barrier is installed along the steep right edge of this stabilized forest road.*

Figure 5U: A brush barrier alongside a skid trail

Picture note: *Brush has been applied along the left edge of this bladed skid trail.*

BMPs for Brush Barriers

- Pile and pack down brush to achieve close contact with the ground surface.
  -- This may require breaking or cutting large pieces of material into smaller chunks.
  -- Place smaller debris on the ground, before placing larger debris on top, to assure ground contact.
- Use additional BMPs such as silt fences, bales, or filter areas to capture sediment where needed.
- Avoid removing the brush barrier once it is established.

Check Dams

Check dams are short, hardened barriers established within inside ditchlines to slow the speed of runoff and capture sediment. Check dams can also be useful to control the runoff that comes from the outlets of water diversions like those described in Part 1 of this chapter. Stone is frequently used as the check dam, but they can also be built from sandbags, sacks of concrete, logs or other hardened materials.

Figure 5V: Check dams installed within a turnout from a forest road

Picture note: *These rock check dams provide sediment capture within a turnout that drains a graveled forest road. Note the sediment accumulation captured. Some sediment removal may be needed to maintain functionality. The area is well vegetated and stabilized.*

BMPs for Check Dams

- Consider laying down geotextile fabric before placing the check dam's construction material. This keeps material from sinking into the ground.
- Provide ample support at the base of the check dam in order to hold back and contain the sediment.
- Tie-in the base of the check dams with the soil to keep runoff from seeping under or 'blowing out' around sides of the dam location.
- The center of the check dam should be lower than each outer edge to provide overflow capacity of water during heavy flows. In other words, runoff should overtop the middle of the check dam and not around sides or underneath.
- The total height of the check dam should not exceed 3 feet. Taller structures are more prone to failure.
- Space the check dams within the channel so the top of each downslope check dam matches the same elevation as the base of the next higher dam.
- If check dam effectiveness is compromised by sediment buildup, periodically remove built-up sediment from behind the dams. Dispose of or stabilize this material to keep it from washing into waterbodies.

Rolled Erosion Control Products

Rolled erosion control products (RECP) consist of prefabricated blankets, wattles or netting made of natural and/or synthetic fiber materials. These products are most effective on bare ground that is highly susceptible to erosion, such as steep slopes, ditchlines, and locations where establishing vegetation may otherwise be difficult. These products go by many different names: coir logs, straw wattles, coconut/ fiber logs, erosion control mats, erosion control blankets, fiber mats, excelsior mats/logs, and others.

- **Wattles and Logs:** May be used instead of a rock check dam. Their main purpose is to slow runoff, not necessarily to catch sediment.
- **Matting and Blankets:** Used in place of loose straw. These work well on steep slopes such as road or skid trail cut banks, and along ditches or stream channels.

After installing a RECP, leave it in place, do not remove it. The material will break down with time. *Avoid using RECP that has plastic mesh when installing along waterways, to avoid entangling wildlife*. More details on proper use and installation of RECP is available on the NCDOT website: https://connect.ncdot.gov/resources/roadside/Pages/Soil-Water.aspx.

BMPs for Rolled Erosion Control Products

- Follow the manufacturer's specifications for installation.
- Remove rocks, limbs and debris to ensure the material completely and firmly contacts bare soil.
- For logs or wattles:
  - Use wood stakes to secure the wattle in place. Do not pierce through the wattle with the wood stake. Chock the wattle into place on either side using multiple stakes.
  - Use long wire staples to crimp the bottom edge of the wattle firmly against the soil.
  - Place multiple wattles spaced apart like you would for a rock check dam.

- For matting or blankets:
  - Spread grass seed / lime / fertilizer first, before installing the blanket.
  - On a slope, install the blankets up and down the slope, not cross-ways like shingles.
  - Overlap the side edges of blankets across the entire slope face.
  - If tying two blankets on a slope run, overlap the ends and firmly staple into the soil.
  - Bury the top lip of each blanket into the soil, at the top of the slope, like a silt fence.
  - Use several long wire staples to crimp the blanket firmly against the soil. Follow the manufacturer's instructions for placement of staples. This is key to its success.

<<< Helpful Hint >>> When installing RECP near streams or in wetlands, avoid using products that contain plastic mesh netting. The plastic mesh netting has shown to ensnare/entrap reptiles, amphibians and other small animals.

Figure 5W: Check dam made with a coir fiber wattle log, on top of excelsior matting
Picture note: *Wooden stakes are used on either side, not punctured through the wattle log.*

Figure 5X: A series of coir fiber check dams and straw matting along a graveled road
Picture note: *Blankets must be firmly secured to the soil with wire metal staples to prevent runoff from up-lifting the blanket and washing underneath.*

Chapter 6: Stream Crossings

Stream crossings are often necessary for roads and skid trails to gain access to forestland for management. Permanent crossings usually are for roads or in some cases firebreaks. Temporary crossings are most common for harvesting timber or for other short-duration forestry operations such as site prep, tree planting, fertilization or herbicide application. Because of the obvious potential for water quality impacts at stream crossings, there are several rules that require practices be used or actions taken. Since the North Carolina FPGs were enacted in 1990 and revised and readopted in 2018, stream crossings have been the most frequent location on a job site where sediment may get into the water.

Rules Related to Stream Crossings

Forest Practices Guidelines Related to Water Quality (FPGs)

There are nine performance standards, that if followed, provide for exemption from permitting through the N.C. Sedimentation Pollution Control Act. The FPG rule .0203 focuses on stream crossings.

North Carolina General Statute 77-13 and General Statute 77-14

These state laws relate to obstructions in streams and/or ditches and each apply to forestry sites.

DWR/EMC river basin and watershed 'riparian buffer rules'

These buffer rules for specific river basins and watersheds set limitations on stream crossings.

North Carolina Dredge and Fill Law

This state law requires that permits be secured for discharges of dredged or fill material in certain locations within the 20 Coastal Area Management Act (CAMA) counties.

Federal Clean Water Act (Section 404)

There are 15 required BMPs for crossings of a water of the U.S. to maintain the silvicultural exemption.

Figure 6A: Permanent bridge stream crossing for forestland access

Picture note: *The BMPs in this Manual do not cover permanent bridges, but this is a good example of a situation where a bridge was the preferred solution for this forestland owner. Consult with a civil engineer if a permanent bridge is desired. Permits may be needed if crossing a navigable waterway.*

Part 1 -- Planning Stream Crossings

Stream crossings should be carefully planned in advance of their need. They should also be designed or selected based on the crossing purpose, traffic size, longevity, and available funds while meeting water quality objectives. Recommendations are available from the N.C. Forest Service, consulting foresters, soil and water conservation districts, and the USDA-Natural Resources Conservation Service (NRCS). This part provides suggested BMPs for planning stream crossings.

BMPs for Planning Stream Crossings

- Avoid having stream crossings whenever possible.
- Minimize the number of crossings to efficiently access the property while protecting water quality.
- Designate the location of the proposed stream crossing to avoid confusion about where to install it.
- Cross where the stream is relatively straight and narrow.
- Keep approachways to the stream channel relatively flat to control runoff.
- Install crossing at a right-angle (90°) to the stream channel's orientation.
- Maintain as close to normal (pre-construction) streamflow by maintaining depth, width, gradient and capacity of the stream channel at the crossing.
- Conduct construction, installation, and removal work during low-water flow if circumstances allow.
- Stabilize the approachways and/or stream crossing locations so sediment is not transported into the stream as required by the FPGs.

Part 2 -- Stream Crossing Types and Recommendations

Bridges, fords and culverts are the three most common types of stream crossing used in forestry. Many variations of each crossing type exist and can effectively protect water quality when applied in a way that fits the site conditions. General BMPs applicable to each crossing type are included in this chapter.

Figure 6B: Example of a temporary steel bridgemat stream crossing

Figure 6C: Example of a permanent reinforced ford stream crossing

Figure 6D: Example of a permanent culvert stream crossing

Bridgemats

Bridgemats are often made of heavy wood or steel panels and placed over a stream or ditch. They are often the most desirable method to protect water quality because they require minimal in-stream modifications to install. Furthermore, temporary bridges can be used many times, making them cost competitive with one-time use culvert-type crossings. Permanent bridges and bridges open to public access should be built only after consulting a licensed civil engineer.

BMPs for Bridgemats

- Cross where channel banks are firm and stable to provide solid footing to support the bridgemats.
- Maintain one-quarter (1/4) of the total bridgemat length on each channel bank footing.
- Create a solid-surface platform crossing that provides a barrier over the channel to minimize debris, soil, and other materials from falling into the channel.
- If needed, lay down curb logs on either side of the bridgemat crossing to catch debris and soil from falling over the edges into the waterway.
- If needed, retain standing bumper trees ('goal posts') on either side of the approachway onto the bridgemats, to help funnel the drag of trees across the crossing platform.
- Keep equipment out of the channel when installing and removing bridgemats when at all possible.
- Control runoff and/or capture sediment on the approachways.
- As needed, periodically inspect the crossing and take action to provide for safety while protecting water quality from runoff, debris, soil or other pollutants.

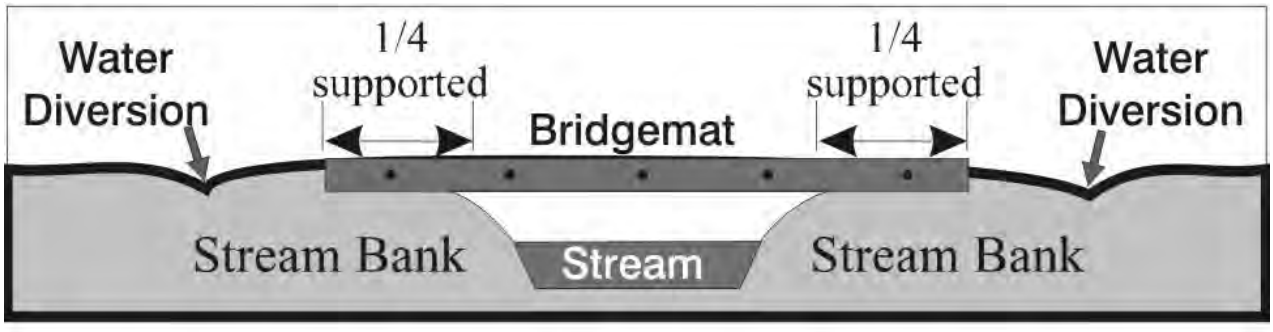


Figure 6E: Schematic drawing of proper bridgemat installation
Picture note: *Note that this figure is a general rule of thumb.*

Figure 6F: Side view of a wooden bridgemat skid trail crossing

Picture note: *Good bank support on each end. Adequate clearance between stream flow and bridgemat. Three panels are used to create a full-width crossing, with no gaps.*

Figure 6G: An example of properly installed steel bridgemats

Picture note: *A skidder traveling over a stream with a set of three steel bridgemats. Bridgemat ends are well supported on the stream bank. Curb logs would be helpful.*

Log Bridges

Temporary bridges constructed of de-limbed logs may be suitable in certain cases. A log bridge is not the same as a 'pole crossing', which is explained below. A log bridge should completely span the watercourse.

BMPs for Log Bridges

- Avoid gouging or damaging stream channel with logs as they are installed and removed.
- Keep logs butted tight to each other to minimize debris and soil from falling between.
- Keep equipment out of the stream when placing and removing logs.

Pole/Log Crossings

A pole crossing is made by stacking logs that are free of limbs and soil within the channel high enough so equipment can travel across. Pole crossings are usually acceptable for temporary access across ditches or short-lived flow paths. A pipe can be inserted at the bottom of the pole stack to further reduce the risk of obstructing water flow in the channel. Pole crossings **are not suitable** for either an intermittent stream that has water, or for any perennial stream.

× **Brush-filled crossings are not acceptable on intermittent or perennial streams, or flowing ditches.**

BMPs for Pole/Log Crossings

- Allow water to pass through the crossing location.
- Protect the integrity of the channel banks during use.
- Use only topped and de-limbed logs that are free of soil and excess debris.
- Use logs of a large enough diameter so they do not pack too tightly together.
- Do not deposit soil within or on top of the pole crossing.
- Pack down limbs, slash, or other woody debris on skid trail approachways, **not in the channel**.
- Promptly remove the pole logs after the crossing is no longer needed, or when rain is forecast.
- Stabilize the crossing location during and after use to prevent accelerated erosion or sediment transport. Recontour the channel banks to preexisting condition.

Figure 6H: A pole crossing installed within a dry ditch for temporary log road access
Picture note: *This pole crossing uses adequately sized logs to provide support and are free of soil, limbs, or excessive debris. Instead of placing soil atop the pole crossing, wooden road pallet/mats are used here to provide a running surface for the log trucks.*

Culverts

Culverts are typically used for forest road stream crossings but can also be used for skid trail crossings. They need to properly sized, installed, and protected from erosion and scour. The size of a pipe needs to be large enough to pass expected flow levels plus additional capacity to pass debris.

Culverts come with some disadvantages: they often clog, frequently block aquatic life passage, require disturbance/backfill in the stream, and require lots of maintenance.

Culverts less than 18 inches clog frequently in a forestry setting. This creates a greater water quality risk if not regularly inspected and maintained. A single larger diameter culvert is preferable over multiple, smaller diameter culverts since the smaller culverts may be more prone to blockages.

BMPs for Culverts

- Use a culvert sized to meet your needs that can carry the expected amount of runoff and streamflow from the upstream watershed. Take into account heavy runoff from storms.
- Use a culvert that will maintain channel width or is at least 18 inches in diameter.
- Use a culvert long enough to extend at least 12 inches beyond the edge of the fill material.
- Protect the inlet and outlet headwalls with rip-rip or other material. Do not use asphalt material.
- Install the culvert crossing during low-flow periods in the stream, if possible.
- Place culvert approximately in the center of the existing or expected water flow within the channel. This may not be the same as the centerline of the channel.
- Set the culvert(s) with a slight downslope grade so streamflow is not impeded and to prevent debris from clogging the pipe. Mimicking the natural stream slope is most desirable.
- Minimize the height that water drops from the outlet of the culvert:
  -- For temporary crossing: Set culvert immediately upon the stream bottom.
  -- For permanent crossing: Embed 10% to 20% of the culvert diameter into the stream bottom.
- Backfill over the culvert with at least 12 inches of suitable material, or one-half the culvert's diameter, whichever is more. Culverts larger than 30 inches diameter should have backfill thickness equal to at least one-third of the culvert's diameter.
- Use backfill material that will pack down tightly. Tamp down the backfill along the length of the culvert to block seepage that may flow around the culvert and wash it out.
- Install bypass flow-ways on either side to allow floodwaters to move around the pipe.
- Apply gravel or other hard surfacing material atop the culvert crossing and on approachways where needed to minimize erosion and sedimentation.

Figure 6-I: Culverts installed for a forest road stream crossing

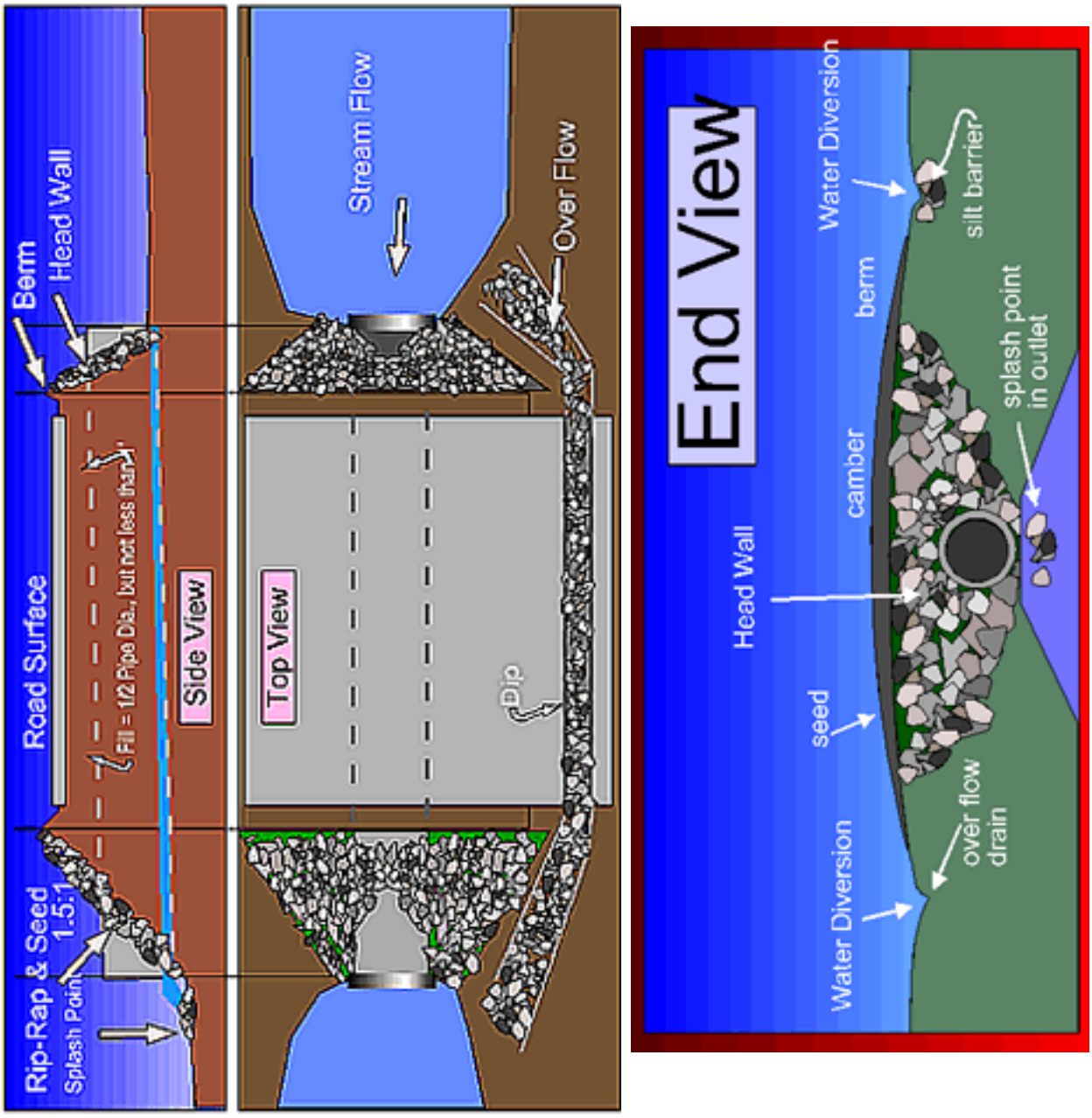


Figure 6J: Schematic views of proper culvert installation

Photo note: *The left illustration (side view) shows proper culvert layout along the contour, with a slight downslope gradient to promote good streamflow and minimize back ups or blockages. The middle illustration (top view) shows the overflow dip that should be installed to allow floodwaters to flow around the culvert location and reduce the likelihood of the culvert blowing-out. The bottom illustration (end view) shows how the road should be crowned over the culvert with rock used to stabilize the inlet and outlets. Water diversions are on each approach.*

Temporary Culverts

The information on this page may be used for temporary installations of round culvert. Table 6-1 is based upon streamflow that may normally be expected from a '1- to 3-year' interval storm-flow event.

These recommendations should only be used:

- **When needed for temporary access.**
- **During dry periods.**
- **On sites with relatively dry soils.**
- **When no rainfall has recently occurred or is forecast to occur while the crossing is needed.**

Table 6-1: Suggested Diameter Sizes of Round Culverts for Temporary Installations.

Average Channel Width (inches)	*Average Channel Depth (inches)*						
	6	***12***	***18***	***24***	***30***	***36***	***42***
12	18	18	18	24	24	30	36
18	18	18	24	24	30	30	36
24	18	24	30	30	36	36	48
30	18	24	30	30	36	48	48
36	18	24	30	36	48	48	48
48	24	30	36	48	48	48	60

How to Measure Average Channel Width for Table 6-1

Measure how wide the channel is at the point of normal high-water mark. Reference Figure 6J below. Take several measurements and average them together to get the average channel width for Table 6-1.

How to Measure Average Channel Depth for Table 6-1

Measure how deep the channel is from the point of normal high-water mark. Reference Figure 6J below. Take several measurements and average them together to get the average channel depth for Table 6-1.

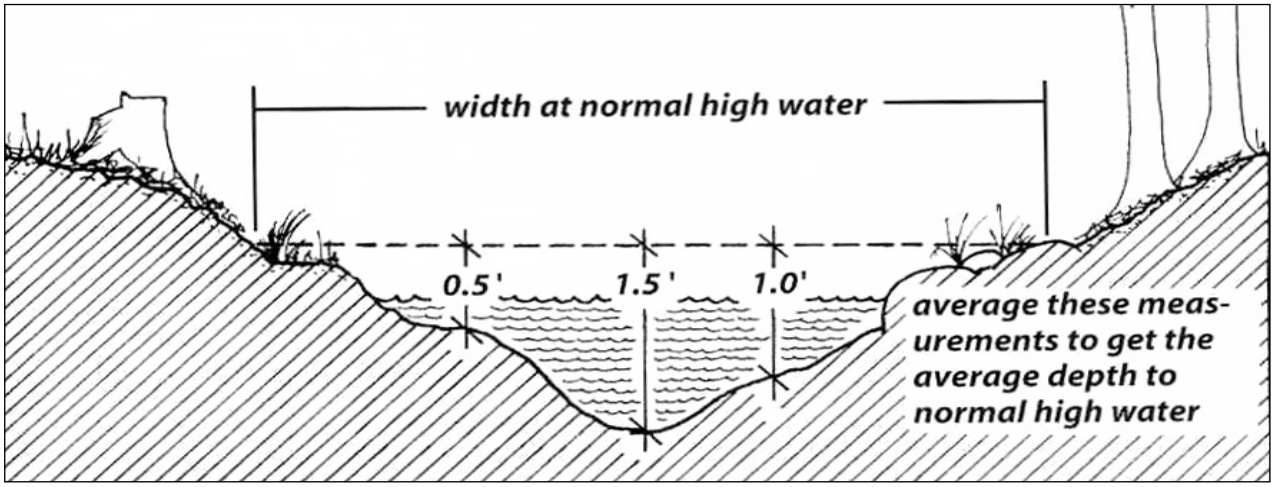


Figure 6K: Sketch of a stream channel cross-section with an example of measurements for determining temporary culvert size

***Picture note**: Do not simply measure how deep the water is. Measure the average streamflow depth at the point of normal high-water mark. Illustration courtesy of Maine Forest Service.*

Permanent Culverts

Table 6-2 is adapted from Talbot's formula for a 2.5-inches-per-hour rainfall. A Talbot's formula table is in the Appendix for further reference. Note that other formulas to determine necessary culvert sizes have been developed and published for localized areas. For example, Douglass (1974)* published culvert and bridge sizes necessary for stream flow in the mountains near Franklin, NC. This reference is commonly referred to as the 'Coweeta culvert formula.' Localized equations and tables are an acceptable substitute. However, if no such data/publication exists in your area, use the table below.

*Douglass, James E. 1974. "Flood Frequencies and Bridge and Culvert Sizes for Forested Mountains of North Carolina". General Technical Report SE-4. USDA-Forest Service, Southeastern Forest Experimental Station. 22 p. https://www.srs.fs.usda.gov/pubs/gtr/gtr_se004.pdf.

In addition, the NCFS has a spreadsheet calculator in the Water Quality section of its website that allows you to change variables and rainfall rates to estimate the size for a round culvert.

Table 6-2: Suggested Diameter Sizes of Round Culverts for Permanent Installations.

	Impervious 100% runoff	Steep slopes, heavy soils, moderate cover		Moderate slopes, heavy to light soils, dense coverrecommendation information		Gentle slopes, agricultural-type soils and cover		Flatland pervious soils
	The letter 'C ' indicates the amount of runoff to expect. High value C means more runoff and heavier streamflow volume Low value C means less runoff and lighter streamflow volume							
Acres	*C = 1.00 Bare Soil*	*C = .80 Higher Runoff*	*C = .70 Lower Runoff*	*C = .60 Higher Runoff*	*C = .50 Lower Runoff*	*C = .40 Higher Runoff*	*C = .30 Lower Runoff*	*C = .20 Normal runoff*
2	18	18	18	18	18	18	18	18
4	18	18	18	18	18	18	18	18
6	24	18	18	18	18	18	18	18
8	24	24	18	18	18	18	18	18
10	30	24	24	24	18	18	18	18
20	36	30	30	30	24	18	18	18
30	42	36	36	30	30	24	18	18
40	48	42	36	36	30	30	24	24
50	48	42	42	36	36	30	24	24
60	36+36	48	42	42	36	36	30	24
70	30+30+30	48	48	42	42	36	30	24
80	36+36+24	30+30+30	48	48	42	36	30	30
90	48+48	36+36	48	48	42	42	36	30
100	48+48	36+36+24	30+30+30	48	48	42	36	30
150		48+48	36+36+36	36+36+24	30+30+30	48	42	36
200			48+48	36+36+36	36+36+36	30+30+30	48	36
250	**A Note About Multiple Culverts:**					36+36+36	48	42
300	It is recommended that if a crossing requires an opening					36+36+36	30+30+24	42
350	greater than 48 inches, that you use bridging, arch-culverts or multiple						30+30+30	48
400	round culverts. Some options for multiple culverts are offered in this table.						36+36+24	48
450	There may be other combinations that can work.						36+36+30	48
500	Consult with someone who has experience if you are unsure.						36+36+36	30+30+30

Fords

Fords are hardened-surface, low water crossings in which a vehicle drives directly through and across the stream channel. Fords can be narrow or broad but should not be used where the stream is deeply incised or where steep approaches are inevitable. Appropriate places for a ford crossing may include:

- A stream that has an existing rocky bottom surface.
- A crossing that will only see occasional, infrequent use.
- Streams that are too wide for bridgemats or multiple culverts.
- A low-flow stream that often dries up during the year.
- Areas prone to beaver activity that could dam-up a culvert crossing.
- × **Fords are not for skid trails. They are only for truck-road access.**

When installing a ford, select sites that have: (1) low streambanks, (2) solid and level stream bottom and (3) straight section of stream channel.

Figure 6L: A newly renovated and improved ford crossing

Picture note: *This ford crossing has gentle approach grades so runoff can be controlled. Substantial stone is used to stabilize the road approaches and provides a firm base. A shallow trough within the centerline of the stream channel allows continued stream flow during low-flow.*

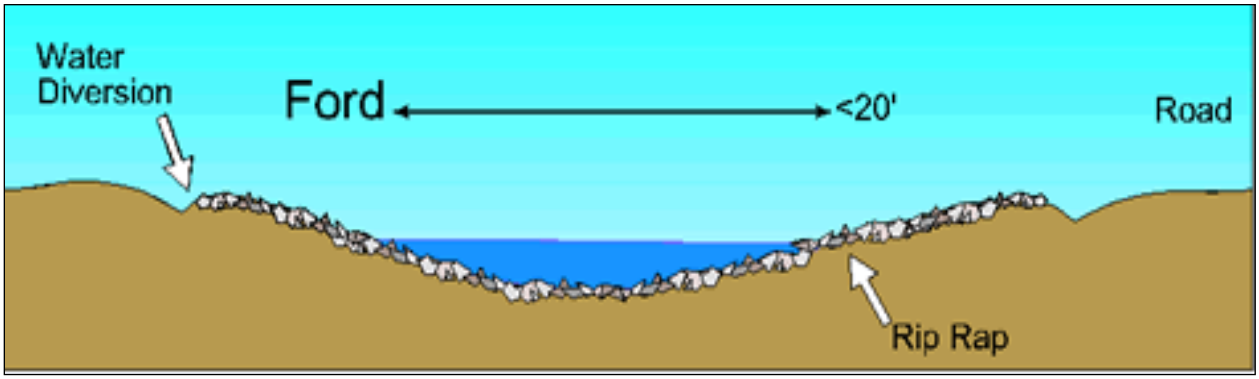


Figure 6M: Cross-section sketch of a ford crossing

Picture note: *This sketch of a ford includes, (1) water diversions, (2) short fording distance, and (3) hardened stream bottom.*

BMPs for Fords

- Minimize the grade of the approachways into the ford crossing.
- Control runoff and capture sediment along and/or from the approachways.
- If the stream bottom is soft and unstable, consider laying down geotextiles as underlayment for the added rock or hardening material. See Geotextile section in Ch. 7.
- Use clean stone or other suitable hardening materials to create a firm vehicle traffic surface. Do not use asphalt or live concrete.
- Spread the stone evenly across the stream bottom to avoid dips or humps that could alter streamflow.
- Leave a low trough within the centerline of the channel so streamflow can continue during low-flow or dry periods.
- Apply clean gravel along the first 100 feet of the approachway. Provide at least 80% coverage.
  -- If the soil is soft, install geotextile underlayment before dumping the clean gravel.

Figure 6N: A well-stabilized ford crossing with gentle road approaches

Photo note: *This ford crossing has ample stabilization on the roads and along the berms. The gentle approach grades help make this an ideal location for a ford.*

Figure 6O: Ground-level view of a newly installed ford

Chapter 7: Forest Roads, Skid Trails and Log Decks

Part 1 -- Forest Roads

Forest roads are often needed for forest management and they require an investment to properly plan, construct and maintain. Long-term erosion and sediment control problems can result from poorly-built or poorly-maintained forest roads. In wetlands, roads can be challenging to build and maintain (see Ch.8). In all cases, multiple BMPs are needed. Landowners should consider alternative options when evaluating the need to build new roads in their woodlands. Roads disturb the continuity of the forest landscape, create a corridor that can enable the spread of invasive plants and may attract trespassers.

If a road is needed, it is best for a landowner to hire an experienced road contractor to design and build the road and not rely upon a logger or timber buyer to build the road.

Forest roads are subject to laws and rules requiring that certain practices be implemented, or actions be taken to protect water quality. This part provides BMPs for planning, constructing and maintaining roads. In addition to this BMP manual, listed below are detailed reference guides for forest roads:

- ✓ "Environmentally Sensitive Maintenance Practices for Dirt and Gravel Roads", from the USFS and Penn State University: https://www.fs.fed.us/t-d/php/library_card.php?p_num=1177%201802P
- ✓ "A Guide for Forest Access Road Construction and Maintenance in the Southern Appalachian Mountains", from the NCFS: https://www.ncforestservice.gov/publications/WQ0214.pdf
- ✓ "Low-Volume Roads Engineering: Best Management Practices Field Guide", from the USFS: https://www.fs.fed.us/t-d/programs/forest_mgmt/projects/lowvolroads/

Road standards describe the quality of the road. Each of the following pictured road examples can meet water quality goals if the use of the road fits the appropriate traffic volume and weight.

Figure 7A: A forest haul road built to a high standard

Picture note: *Greater traffic frequency anticipated compared to the following pictured examples. Note the use gravel, silt fence, vegetation, and water control structures.*

Figure 7B: A forest haul road with lower road standards than figure 7A

***Picture note**: Compared to 7A, this road is narrower, has more bare soil, fewer water control structures, and steeper grade.*

Figure 7C A forest haul road with lower road standards than figure 7B

***Picture note**: Compared to 7B, this road is narrower, has more bare soil, and fewer water control structures. However, the traffic volume is much less and therefore may not need as many BMPs to provide similar water quality protection as the road in figure 7B.*

Figure 7D: A forest haul road with the lowest road standards of the examples shown
Picture note: *Compared to the previous three examples, this road is narrower, heavily shaded, and partially covered by leaves, sticks and other organic debris. Traffic volume is infrequent and therefore does not need as many BMPs to provide similar water quality protection to the other examples. Assuming the remainder of the road is stable and future access is not needed, it is best for water quality protection to allow the road to naturally recover.*

Rules or Laws Related to Forest Roads

Forest Practices Guidelines Related to Water Quality (FPGs)

There are nine performance standards that, if followed, provide an exemption from the permitting requirements of the N.C. Sedimentation Pollution Control Act.

North Carolina General Statute 77-13 and General Statute 77-14

These state laws prohibit obstructions in stream and/or ditches.

DWR/EMC river basin and watershed 'riparian buffer rules'

The riparian buffer rules set limitations on stream crossings within the 50-foot buffer zone.

U.S. Army Corps of Engineers 15 mandatory best management practices for forest roads.

Construction of forestry roads in wetlands or installing a crossing of a waters of the U.S. does not require a Clean Water Act permit so long as these 15 federal BMPs are implemented.

U.S. Army Corps of Engineers Guidance Constructing Forest Roads in Wetlands of NC.

This information guidance should be followed when planning for and constructing new forest roads in wetlands.

North Carolina Dredge and Fill Law

This state law requires that permits be obtained for discharges of dredged or fill material in certain locations within the 20 Coastal Area Management Act (CAMA) counties.

The Use of Gravel

Gravel can help provide all-season access for log trucks while protecting streams and highway entrances from sedimentation. When used effectively, gravel can increase the operability window and the productivity of an operation. Gravel provides cover and stabilizes soils, which can protect water quality. When used ineffectively, gravel will sink into the subgrade leaving bare erodible soil at the surface. This can lead to operational inefficiency and sedimentation.

Where to Use Gravel

Gravel is commonly applied where soil erosion can result in sedimentation and/or where trafficability needs support such haul roads, stream crossings or decks. Occasionally, it may be necessary to gravel an entire access road from the public road to the deck. If the road must be used in all-weather conditions, gravel will keep the road more passable and help prevent sedimentation that will be more evident with heavy use in wet weather. Gravel application should be considered at:

Roads with stream crossings: Gravel is commonly placed along the entire road surface with several stream crossings, on the approachways, or on wet areas so mud is not tracked.

Road entrances: Gravel is commonly placed at logging road entrances to prevent mud from getting onto the highway. A general rule-of-thumb is to apply gravel 100 feet in from the public road. This often allows the mud/soil to be dislodged from truck tires before reaching the public road. If trucks are pulling a lot of mud into the gravel, it may be necessary to replenish the gravel or reevaluate options to maintain a clean public roadway.

Culverts: Gravel atop of culverts may be necessary to prevent sedimentation and maintain trafficability.

Roads within or near Streamside Management Zones (SMZs): Gravel should be strongly considered for roads located within 100 feet of a stream.

How Much Gravel to Use

In most situations, a minimum of 6 to 8 inches of stone is needed to support logging trucks for any length of time. Using geotextile underlayment may allow less gravel to be used.

Common Types of Gravel

The type of gravel to use is also a very important decision. Don't make the mistake of telling the quarry to, “give me the cheapest you've got”. Such a request will almost always result in crusher run (“ABC”) gravel. For most logging applications, ABC gravel may not be the best or even the cheapest option. The best rock for roads tends to be relatively hard and heavy and have angled edges.

ABC Gravel: ABC gravel typically contains stone that is no larger than 1 to 1.5 inches. ABC and 3-inch crusher run gravel contain a high percentage of fines (stone dust or sand) that may add little or no additional strength to a road. However, in some places the fines may help by bonding the stone together with the roadbed matrix, creating a firmer travel surface on loose soil.

Aggregate Stone: On newly constructed roads, stone larger than ABC gravel is preferred because it provides more strength to support heavy equipment. A minimum of 6 to 8 inches of depth should be applied. If a smoother road is required later, a layer of crusher run gravel can be spread on top.

Aggregate stone comes in many sizes and can be named differently by area or even quarry. Three-inch (3”) average gravel size is preferred on any area where washed stone will not bond well to the road surface, such as heavily compacted roadbeds, rocky areas, and where geotextile fabric is used. Larger clean/washed stone, often called “surge rock” or railroad ballast usually is good for access entrances, roads and log decks.

Cost and Availability of Gravel

In considering the cost of crusher run versus washed stone, realize that 25% to 45% of the weight of crusher run gravel is composed of fine particles smaller than 2 millimeters.

Quarries price gravel on a per-ton basis. The table below shows cost comparisons between ABC crusher run and #45 or #57 stones based on prices at several North Carolina quarries. The cost of washed stone may actually be lower when you look at the amount of road it will cover. The washed stone will also provide a much more durable road surface in most cases.

Table 7-1: Cost Comparison of Three Types of Gravel.

Gravel Type	Stone Size	lbs/ft^3	$/Ton*	Average Cost per 100' of Road (4" deep x 12' wide)
ABC	1" - 1.5" plus fines	140	$21.51	$602.28
#45 or #57	1" - 3" aggregate	100	$26.71	$534.20
A/B rip rap	3" - 5" aggregate	100	$29.38	$587.60
* Based on an average from several quarries across N.C. in 2017.				

For estimating gravel and other road related costs visit:
https://www.ncforestservice.gov/water_quality/CFGroadcostestimatingspreadsheet2010.xls

Geotextile

Geotextile fabric can keep fine soil particles in the roadbed (subgrade) from getting mixed into the gravel or rock that is laid atop the road surface. When fine soil particles mix into the gravel surface, the road's load-bearing capacity reduces, often resulting in rutting of the roadway. Geotextiles should let water pass through it at the same rate or slightly faster than the adjacent soil. These products can extend the useful life of the road, which ultimately saves you time and money.

If a road must be used immediately after it is built, one of the best ways to avoid losing gravel in soft spots is to first install geotextile before dumping gravel. The geotextile will allow water to pass through but hold the gravel up at the surface where it should be. At a cost of about $1.33 per linear foot, the fabric can pay for itself by reducing the amount of gravel needed in soft areas. Geotextile fabric is commonly available in 300 to 400 foot rolls.

Selecting geotextile type

Two common types of geotextile are woven and non-woven. Each has its own best application. Consider the material strength properties when selecting a product. Check the strength properties described in manufacturer's specifications; look for terms such as burst or abrasion resistance, puncture, grab, or tearing strength.

Woven: This is made of flat, thin strips of poly material similar to silt fence. Those strips are literally woven together in a very tight grid pattern, creating strong tensile strength. This is used when building on poor/soft soils that cannot support heavy loads. It has stronger load-bearing capacity than non-woven. If building a road through mucky soft soils, then you want to use woven geotextile placed upon the native soil, to help carry the load of the roadbed fill material. It allows water to slowly pass through.

Non-woven: This is felt-like cloth material that easily allows water to pass through. It has lower strength than the woven and is easily ripped or punctured. It is used as a separation layer or to allow filtration such as wrapping a French drain or placing under gravel when the roadbed is already strong/firm and can carry the load by itself and is well-drained. In this case, non-woven geotextile simply separates the gravel from the soil, keeping the stone from mashing down into the roadbed. It is not providing structural carrying capacity.

Tips for Selecting Geotextiles

- Select geotextile that will perform best for your given soil, moisture, equipment, traffic and expected amount of gravel surfacing. Find out from others who have used geotextiles what worked best for them.
- You will need to know the soil characteristics and permeability of the roadbed, and match them to the permeability of the geotextile fabric.
- Select geotextile that can withstand installation and survive the construction period without puncturing, tearing, bursting, or fraying.
- Use the correct type of surfacing material. If gravel is to be used for the road and traffic will travel directly on the aggregate, then you must provide more fines (15% or more) or the aggregate will slip off the fabric.

Steps to Install Geotextiles*

* Excerpted and adapted from: "Geotextiles in Road Construction, Maintenance and Erosion Control". College of Engineering, University of Massachusetts at Amherst, undated.

1. Shape the roadway and establish the crown. Roll the fabric down the road. Standard roll widths usually make it necessary to use one roll per lane of road.
2. If there is much wind, you may need to weight the sides and end with shovels full of gravel, or use spikes to pin the fabric down.
3. Overlap the fabric at the centerline as recommended by the manufacturer's instructions. The absolute minimum overlap recommended is 12 inches. Overlap the end of the preceding roll over the top of the next roll in the direction that the gravel will be spread to minimize wrinkles and shoving of the geotextile fabric during spreading and blading of gravel.
4. Dump and spread the gravel or base course material using normal methods. But make sure you do so in the direction of the laps. A minimum of one-foot of surfacing material is typically recommended.
5. In unusual conditions, particularly in extremely wet and soft areas, end dump trucks should back up while depositing gravel. This allows the truck to be driven on the gravel rather than on the fabric and will minimize rutting of the subgrade by the truck tires.
6. When two or more rolls are used side by side, always dump aggregate on the top layer and blade over the lap to the next layer. ***Avoid driving onto the geotextile fabric with any equipment.***
7. If the geotextile is ripped or torn during gravel placement, place a piece of geotextile over the torn area to cover 3-feet in all directions from the tear.
8. Once the surfacing material has been applied over the geotextile, begin blading. Be careful that the blade does not dig into the base course and displace or rupture the fabric.
9. If rutting of the subbase occurs after the geotextile has been placed, the ruts should be filled with new gravel. Do not attempt to regrade the existing surface without adding new gravel since you may tear the geotextile.


Figure 7E: Geotextile and gravel being applied atop a renovated legacy forest road

BMPs for Planning Roads

- Consider using maps, aerial photos, and own on-the-ground site exam to determine road placement.
- When feasible, plan to construct roads at least one year before usage to allow the roadbed to stabilize and settle before use.
- Minimize the number of stream crossings. Avoid crossings when possible.
- Minimize soil disturbance and road placement within ephemeral drainages. If roads are needed within an ephemeral drainage, consider using BMPs to control runoff and capture sediment.
- Establish roads along the land contours when conditions allow:
  -- In steep terrain, try to establish roads along gentle hill slopes, just below the ridgeline. This allows better runoff control and keeps the road from downcutting into the ridgeline, which creates an erosion channel.
- Try to keep the road atop firm and well-drained soils. Avoid wet-natured soils, loose soils, or highly erodible soils if possible.
- Plan the road location and construction to minimize the amount of cut and/or fill needed.
- Look for opportunities to naturally drain runoff from the road, but never directly into streams or other waterbodies. Avoid placing outlets within ephemerals where possible.
  -- Often the best solution in steep terrain is to construct an outsloped road with broad-based dips or other suitable BMP tools to control runoff.
- Plan adequate right-of-way widths to provide ample sunlight for drying the road surface.

BMPs for Constructing Roads

- Construct roads at the minimal width that meets your safety and traffic needs while protecting water quality and allowing adequate runoff control:
  -- Travel surfaces of 10 to 14 feet, with intervals of wider road for passing, are usually suitable for light-duty roads.
  -- Travel surfaces from 14 to 20 feet, or slightly more, may be needed for frequently used roads.
- Keep grade slopes to 10% or less when conditions allow.
- For grades steeper than 10%, limit road segment lengths to 200 feet or less when possible to better control runoff and capture sediment.
- Limit height of side / cut banks to 5 feet or less if possible:
  -- For loose soils, the side / cut bank should be sloped at a ratio no steeper than 2:1 where site conditions allow.
  -- For tight soils, a steeper side / cut bank may be acceptable, but generally should be no steeper than a ratio of ½:1.
  -- Roads with side / cut banks steeper than 1:1 or more than 5 feet tall should only be constructed when no other practical alternative exists.
- Minimize soil disturbance and the amount of road at any stream crossings in accordance with **FPG .0201** and **FPG .0203**. Also see Part 5 of this Chapter for BMPs on stream crossings.
- Establish access entrances to public roads in accordance with **FPG .0204**.
  -- Use rock, stone, wooden mats, or other suitable materials for a distance of at least 50 feet from the public road, if soil conditions require.
- Stabilize bare soil areas in accordance with **FPG .0209**. Also see Ch.11 for seeding suggestions.
- In low-lying areas, especially prone to flooding, keep the roadbed height as close to the original ground level as possible, to minimize potential blockage of overland surface water flow. When fill material is needed, provide adequate cross drainage.
- Use insloping, outsloping or crowning to provide drainage of road surface and control runoff. This may require excavation of an inside ditchline to carry runoff.
- Control and capture runoff.
- Stabilize and/or harden the road surface as needed to provide runoff control and vehicle access. Consider using geotextile fabric as underlayment.
- Consider using full-bench construction in sloping terrain where soil is loose and prone to sliding or accelerated erosion. A full bench road is cut entirely into the side / cut bank, with all excavated spoil material hauled away. No spoil is side-cast over the downslope edge, therefore the roadbed sits entirely upon a solid, undisturbed soil bank.

BMPs for Maintaining Roads

- Rehabilitate and stabilize the road and side / cut banks according to the standards of **FPG .0209.**
- Monitor the condition of the road and its BMPs to see if runoff is being controlled and captured as intended. Take prompt action to protect water quality if BMPs are not properly functioning.
- Clean out built-up silt and sediment as needed from sediment traps, silt fences, bales, check dams, brush barriers or other places where sediment poses a risk to water quality.
- Maintain an open daylight corridor that provides suitable drying for the road surface.
- Maintain a road surface with good runoff control, water quality protection, and vehicle access.
- Close access to roads when suitable to minimize unnecessary use.
- If practical, perform road and ditch maintenance during times when heavy rain is not expected, so freshly tilled soil is less likely to be exposed.
- Consider applying erosion control measures within ditches to reduce scouring of the soil.

Part 2 -- Skid Trails

Skid trails are pathways used to transport felled trees, logs, and other forest products from the woods to a deck or roadside. Skid trails are usually for temporary use. However, like forest haul roads, they should be planned, constructed, and either maintained or closed-out. Failure to do so can have long-lasting impacts on water quality. The BMPs here may also be suitable for temporary forest roads.

Types of Skid Trails

There are two general types of skid trails: bladed and overland.

Bladed: These are excavated and almost always expose more soil than overland trails. The grade can be controlled by the excavation and/or fill of the terrain. Bladed trails usually require more BMPs.

Overland: These are pathways immediately atop of the soil surface. Usually less soil is exposed, but rutting and compaction is commonly observed. BMPs are often needed to promote runoff infiltration and to prevent soil erosion. Applying slash early and often is an effective BMP.

Rules or Laws Frequently Referenced for Skid Trails

Forest Practices Guidelines Related to Water Quality (FPGs)
There are nine performance standards that, if followed, provide an exemption from the permitting requirements of the N.C. Sedimentation Pollution Control Act.

North Carolina General Statute 77-13 and General Statute 77-14
These state laws prohibit obstructions in stream and/or ditches.

U.S. Army Corps of Engineers 15 mandatory best management practices for forest roads.
Construction of forestry roads in wetlands or installing a crossing of a waters of the U.S. does not require a Clean Water Act permit so long as these 15 federal BMPs are implemented.

North Carolina Dredge and Fill Law
This state law requires that permits be obtained for discharges of dredged or fill material in certain locations within the 20 Coastal Area Management Act (CAMA) counties.

Figure 7F: A bladed skid trail in the Mountains

Figure 7G: An overland skid trail in the Piedmont
***Picture note**: It would be best to apply logging slash on this sloping trail to control erosion.*

Figure 7H: A shovel trail on an active logging job in the Coastal Plain
***Picture note**: The logs and debris should be removed before completing the harvest.*

BMPs for Skid Trails

- Control and capture runoff. Some examples include waterbars, rolling dips or turnouts.
- Minimize gouges or trenches in the soil caused by the skidding of logs or trees.
- Concentrate skidding on as few skid trails as possible by avoiding widespread/random skidding.
- Where possible, limit primary skid trails to 10% of the total working area.
- Minimize placement and use of skid trails in ephemeral drainages.
- Minimize skid trail width. Avoid creating two lane skid trails.
- On sloping terrain, follow the land contour.
- Keep skid trails to less than 25% grade slope if possible.
- Frequently pack down leftover logging debris atop primary skid trails to minimize soil disturbance and provide erosion control:
  -- To be most effective, this should be done as the skidding occurs, not simply after the job is over. As the equipment operates on the debris, it helps break down the debris with each pass.
  -- Packing down logging debris is often an effective and affordable BMP to install at the approaches to stream crossings.

Part 3 -- Decks

Log decks are staging areas where trees, logs or other forest products are received from the skidding operation and loaded onto trucks for transport out of the job site. They may also be called landings, set-outs or ramps. Because of the disturbance to exposed soil and repeated equipment traffic in a concentrated area, decks have the potential to produce significant runoff and erosion.

Figure 7-I: Active logging deck

Picture note: *Logging slash or other groundcover should be applied upon completion if needed to prevent erosion and sedimentation.*

BMPs for Decks

- Minimize the number and size of decks.
- Establish decks at locations where soil disturbance is minimized. Examples include outside of ephemeral drainages, upon flat terrain and well-drained soil.
- Keep decks outside of the SMZ wherever possible. If a deck must be sited within the SMZ, read and understand the requirements of rule FPG .0201.
- Control runoff and/or capture sediment that flows across or off the deck.
- Frequently pack down logging debris to minimize soil disturbance and provide erosion control.
- If decks must be placed on steep ground:
  -- Select side-ridge locations high on the slope, to provide as much room as possible for controlling runoff and/or capturing sediment before it reaches a waterbody at the bottom of the slope.
  -- Use more BMPs than usual to control runoff and capture sediment.

Figure 7J: Logging deck with mats

***Picture note**: The road mats reduce soil compaction and rutting, minimizes soil from being deposited onto the public roadway, and creates a firm base for log trucks.*

Chapter 8: Silvicultural Activities in Forested Wetlands

DISCLAIMER: ***The information in this chapter: (1) is not a full description of all applicable regulations or guidance; and (2) does not constitute legal advice. The U.S. Army Corps of Engineers (USACE) and the U.S. Environmental Protection Agency (EPA) retain final authority to determine the applicability of, and compliance with, federal regulations; including agency-issued guidance for maintaining the exemptions in Section 404(f) of the Clean Water Act.***

This chapter includes discussions about laws, rules, regulations, and guidance documents and some direct quotes of regulations:

- All direct quotes from laws, regulations, or guidance documents are cited according to the method described in *How To Use This Manual*.
- Guidance from regulatory agencies provides additional information on specific regulations and how to implement them. Such guidance should be followed unless a regulatory agency representative provides an exemption from that guidance.

Part 1 -- Introduction to Forested Wetlands

Forested wetlands provide important water quality and ecological functions. They have complex soil and hydrologic conditions that often require additional attention when planning and conducting forestry operations. Because of the value of these functions and the complexity of this resource, several federal and state regulations have been enacted to minimize degradation of wetlands. These regulations have led to mandatory BMPs for specific situations. In addition, there are supplemental recommended BMPs outlined in this chapter.

Objectives

The objectives of the BMPs recommended in this chapter include:

- Meeting the requirements of the Clean Water Act (CWA) Section 404 silviculture exemption and policy guidance from the EPA/USACE.
- Addressing provisions of state of North Carolina wetland rules that affect forestry operations.
- Avoiding and minimizing adverse impacts on wetlands water quality, both on-site and off-site.
- Protecting hydrologic functions of forested wetlands that are being managed for silviculture.
- Protecting soil physical properties that could impact hydrologic functions.

Steps for Knowing the Rules

1. Read the recommendations in this manual and associated guidance references. They are written to help you implement effective systems of BMPs and understand the regulations.
2. Consult with the appropriate agency as needed to discuss applicability of the BMPs for your site.
3. Check for the most recent versions or interpretations of regulations and regulatory guidance.

Wetland Regulatory Agencies

Wetlands are regulated at both the federal and state level. The U.S. Environmental Protection Agency (EPA) and U.S. Army Corps of Engineers (USACE or Corps) are the two lead agencies regarding federal wetland regulations. The USACE is delegated the authority by the EPA to administer the wetland regulations that most commonly effect forestry.

In North Carolina, the NCDEQ-Division of Water Resources and Division of Coastal Management also have authority to regulate certain wetlands.

Primary Federal Agency: **U.S. Army Corps of Engineers**
Contact: Wilmington District, Regulatory Division
Website: https://www.saw.usace.army.mil/Missions/Regulatory-Permit-Program/

State Agency: **NCDEQ Division of Water Resources (DWR)**
Contact: 401 & Buffer Permitting Branch
Website: https://deq.nc.gov/about/divisions/water-resources/water-quality-permitting/401-buffer-permitting-branch

State Agency: **NCDEQ Division of Coastal Management (DCM)**
Contact: CAMA and Dredge & Fill permits (20 Coastal Zone counties)
Website: https://deq.nc.gov/about/divisions/coastal-management

Assess Your Site for Wetlands

When planning a forestry activity, you should assess your site to see if the regulations and BMPs associated with forested wetlands apply to your activity. Refer to Appendix 8 for descriptions of seven common types of forested wetlands.

To be considered a wetland, a site must exhibit positive evidence of hydrophytic vegetation, hydric soils and wetland hydrology. If you think there is a need to have a jurisdictional determination of wetlands on your site, contact the USACE to request an assessment.

<<< Helpful Hint >>>
To make a legally-binding wetland jurisdictional determination (known as a "JD"), a person must be qualified through training using the USACE methodology.

The three steps below are for general reference, and are not full descriptions of the indicators used to determine the legal existence of wetlands for federal or state jurisdiction.

Step 1. Examine for hydrophytic vegetation.

Hydrophytic vegetation is present when the plant community is dominated by species that require or can tolerate prolonged inundation or soil saturation during the growing season. Hydrophytic vegetation decisions are based on the assemblage of plant species growing on a site, rather than the presence or absence of particular indicator species. Two helpful references are listed below:

"Classification of the Natural Communities of North Carolina, Third Approximation", published by the N.C. Natural Heritage Program. https://www.ncnhp.org/.

"Classification of Wetlands and Deepwater Habitats of the United States", published by the U.S. Fish and Wildlife Service (also known as the 'Cowardin' manual). https://www.fws.gov/wetlands/documents/classwet/index.html.

Step 2. Examine for hydric soils.

Hydric soil forms under conditions of saturation, flooding, or ponding long enough during the growing season to develop anaerobic conditions in the upper part. Most hydric soils exhibit characteristics that result from repeated periods of saturation or inundation that last more than a few days. Saturation or inundation, when combined with microbial activity in the soil, causes the depletion of oxygen. This anaerobic condition promotes certain biogeochemical processes, such as the accumulation of organic matter and the reduction, translocation, or accumulation of iron and other reducible elements. These processes result in distinctive characteristics that persist in the soil during both wet and dry periods, making them particularly useful for identifying hydric soils in the field.

The USDA-NRCS maintains a free online tool called Web Soil Survey, websoilsurvey.nrcs.usda.gov. The soil drainage class, such as Poorly Drained or Very Poorly Drained, are also often associated with wetlands. Take soil core samples and examine for hydric soil characteristics.

Step 3. Examine for wetland hydrology

Wetland hydrology indicators are used in combination with indicators of hydric soil and hydrophytic vegetation to determine whether an area is a wetland. Wetland hydrology indicators provide evidence that the site has a continuing wetland hydrologic regime and that hydric soils and hydrophytic vegetation are not relicts of a past hydrologic regime. Some hydrology indicators are naturally temporary or seasonal, and many are affected by recent or long-term weather conditions. For example, surface water or saturated soils often are present only during the normal wet portion of the growing season and may be absent during the dry season or during drier-than-normal years.

Hydrology indicators also may be subject to disturbance or destruction by natural processes or human activities. However, some wetlands may lack any of these indicators due to temporarily dry conditions, disturbance, or other factors. Therefore, the lack of a hydrology indicator is not evidence for the absence of wetland hydrology.

Part 2 -- Federal Regulations, Terms and Concepts

Clean Water Act

The Clean Water Act of 1977 (CWA) establishes federal authority for regulating activities effecting the chemical, physical and biological integrity of the nation's waters. The CWA has several sections, with each explaining certain aspects of the regulation. The sections most commonly of interest to the forestry community are noted here:

Section 301: Discharges of pollutants (including sand, rock and other fill materials) into the nation's waters is unlawful except if it is in compliance with the provisions of the CWA.

Section 303: Waterbodies that contain too much of a specific pollutant must be identified, and a Total Maximum Daily Load (TMDL) plan must be developed to restore the degraded water quality. These TMDL plans may result in additional protections required along waterways that are designated as Impaired.

Section 401: When a permit is issued under the CWA to authorize a discharge into a waters of the U.S., the state must also issue a certification that the discharge complies with state requirements. The NCDEQ-Div. of Water Resources administers the provisions of Section 401.

Section 404: Outlines the procedures for permitting discharges of dredged or fill material from, or into, a waters of the U.S. This section also describes certain exemptions from permitting, along with the conditions that must be met in order to maintain that exemption.

Forestry or "silviculture" activities are exempted from having to obtain permits for discharging dredged or fill material, as cited within Section 404. However, there are several requirements that forestry activities must comply with, in order to maintain this exemption.

Federal Definition of Waters of the United States (WOTUS) and Adjacent Wetlands

The Section 404 regulations apply to all "waters of the United States" which also includes "adjacent wetlands". Since 201, there have been multiple attempts by the federal government to clarify the definition of these terms. The definition is important, because it describes which waterways and wetlands are federally-protected by the Clean Water Act, versus those waters/wetlands that may otherwise be protected by an individual state's laws/rules.

Due to remaining uncertainty about this definition, please reference the EPA's website for the current status of defining these terms: www.epa.gov/wotus.

A Note on Section 404 Permitting History and Phase-In Dates

July 25, 1975: The USACE published regulations identifying a phase-in schedule to implement the permit requirements of Section 404. A Section 404 permit was required for discharges of dredged or fill material into navigable waters of the U.S. and wetlands adjacent to these waters.

September 1, 1976: Permit requirements were expanded to include discharges into primary tributaries of navigable waters of the U.S. and adjacent wetlands, as well as natural lakes greater than five acres in surface area.

July 1, 1977: Permit requirements were expanded to include all waters of the U.S.

July 19, 1977: The USACE issued Nationwide Permits authorizing all activities occurring before these phase-in dates. Silvicultural activities occurring in wetlands before these phase-in dates were thus deemed permitted and, unless the activities are modified, require no further permitting. This means that areas that were sufficiently drained to convert a wetland to a non-wetland, and which remain in that drained condition, are not now jurisdictional wetlands and are not subject to Section 404. Maintenance of historical/legacy ditches that were installed before this date is considered exempt because their construction was not, at that time, a violation of the CWA.

A Note on Wetland Size

It is important to understand that the provisions of the CWA apply to all jurisdictional wetlands regardless of size. The North Carolina standards also apply equally to all wetlands regardless of size, status or classification.

Small wetlands often occur in larger areas and may not be mapped with hydric soils. Forestry activities should take into account these small areas, and consider alternative prescriptions to sustain them. Shallow, ephemeral wetlands are important to sustain many species of at-risk plants and animals.

Part 3 -- State of North Carolina Wetland Regulations

North Carolina Wetland Definition

The N.C. Environmental Management Commission has adopted the federal definition of wetlands (with a slight revision in wording), as cited below from 15A NCAC 2B .0202 (61):

<*start citation*> "Wetlands are "waters" as defined by G.S. 143-212(6) that are inundated or saturated by an accumulation of surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands do not include prior converted cropland as defined in the National Food Security Act Manual, Fifth Edition." <*end citation*>

North Carolina Wetland Standards

There are two main state rules about wetlands:

Activities Deemed to Comply with Wetlands Standards, rule 15A NCAC 02B .0230:

This rule repeats the federal section 404 activities that are exempted from permitting, and are considered to meet the state's wetland standards. However, in addition to the federal requirements of Section 404, the activity must also comply with the FPGs.

Wetland Standards, rule 15A NCAC 02B .0231:

This rule describes the uses for which wetlands shall be protected and standards to meet for maintaining those uses.

The North Carolina 'Dredge and Fill Law'

North Carolina G.S. 113-229 is commonly known as the Dredge and Fill Law, and requires permits to dredge or fill in or about estuarine waters or State-owned lakes. The NCDEQ-Division of Coastal Management issues these permits and administers this law.

Forestry activities (such as road construction, minor drainage, or other activities) that create discharges of dredged or fill material in estuarine waters, tidelands, marshlands, or State-owned lakes will require a permit from the NCDEQ-Div. of Coastal Management.

As cited within N.C. General Statute 113-229(n): *<start citation>*

> "(1) State-owned lakes include man-made as well as natural lakes.
>
> (2) 'Estuarine waters' means all the waters of the Atlantic Ocean within the boundary of North Carolina and all the waters of the bays, sounds, rivers, and tributaries thereto seaward of the dividing line between coastal fishing waters and inland fishing waters agreed upon by the Department and the Wildlife Resources Commission, within the meaning of G.S. 113-129.
>
> (3) 'Marshland' means any salt marsh or other marsh subject to regular or occasional flooding by tides, including wind tides (whether or not the tidewaters reach the marshland areas through natural or artificial watercourses), provided this shall not include hurricane or tropical storm tides. Salt marshland or other marsh shall be those areas upon which grow some, but not necessarily all, of the following salt marsh and marsh plant species:
>
> Smooth or salt water Cordgrass (*Spartina alterniflora*), Black Needlerush (*Juncus roemerianus*), Glasswort (*Salicornia* spp.), Salt Grass (*Distichlis spicata*), Sea Lavender (*Limonium* spp.), Bulrush (*Scirpus* spp.), Saw Grass (*Cladium jamaicense*), Cattail (*Typha* spp.), Salt-Meadow Grass (*Spartina patens*), and Salt Reed-Grass (*Spartina cynosuroides*)." *<end citation>*

N.C. Coastal Area Management Act (CAMA) and Areas of Environmental Concern (AEC)

The North Carolina CAMA regulates development activities in the 20 coastal counties, listed below.

Table 8-1: The 20 Coastal Zone CAMA Counties in North Carolina.

Beaufort	Carteret	Dare	New Hanover	Pender
Bertie	Chowan	Gates	Onslow	Perquimans
Brunswick	Craven	Hertford	Pamlico	Tyrrell
Camden	Currituck	Hyde	Pasquotank	Washington

The CAMA requires permits for development in Areas of Environmental Concern (AEC). An AEC is an area of natural importance. It may be easily destroyed by erosion or flooding, or it may have social, environmental, economic or aesthetic values valuable to North Carolina. The CAMA allows the N.C. Coastal Resources Commission to exempt some types of minor maintenance and improvements. These types of projects are those with successful track records in protecting the resources around them. For assistance in determining whether or not your project qualifies for an exemption, you can contact the NCDEQ-Div. of Coastal Management.

You must obtain a CAMA permit for your project if it meets all of the following conditions:

- It is in one of the 20 counties covered by CAMA;
- It is considered 'development' under CAMA;
- It is in or it affects an AEC established by the N.C. Coastal Resources Commission; and,
- It does not qualify for an exemption.

You are probably in an AEC if your project meets any of the following:

-- In or on navigable waters within the 20 CAMA counties.
-- On a marsh or wetland.
-- Within 75 feet of the mean high-water line along an estuarine shoreline.
-- Near the ocean beach.
-- Near an inlet.
-- Near a public water supply.
-- Within 30 feet of the normal high-water level of areas designated as inland fishing waters by the N.C. Marine Fisheries Commission.

North Carolina CAMA Permit Exemptions

Section 103(5)(b) of the CAMA exempts the following activities from permitting requirements:

- Road maintenance within a public right-of-way.
- Utility maintenance on projects that already have CAMA permits.
- Energy facilities covered by other laws or N.C. Utilities Commission rules.
- Agricultural or forestry production that does not involve the excavation or filling of estuarine or navigable waters or coastal marshland *(**Note:** The activities noted in this bullet are not exempt from permitting requirements under the N.C. Dredge and Fill Law)*.
- Agricultural or forestry ditches less than 6 feet wide and 4 feet deep.
- Emergency maintenance and repairs when life and property are in danger.
- The construction of an accessory building usually found with an existing structure, if no filling of estuarine or navigable waters or coastal marshland is involved.

Part 4 -- Section 404 Silvicultural Exemption

Section 404(f)(1) of the Clean Water Act lists activities which are exempt from permitting to dredge material from or discharge into a waters of the U.S. The exemptions include:

- Normal farming, silviculture, and ranching activities such as plowing, seeding, cultivating, minor drainage and harvesting for the production of food, fiber, and forest products.
- Construction or maintenance of farm roads or forest roads.

To retain the silvicultural exemption in Section 404, forestry activities in wetlands:

1. Must not convert an area of the waters of the U.S. into a use to which it was not previously subject.
2. Must not result in the immediate or gradual conversion of a jurisdictional wetland to a non-wetland.
3. Must not discharge toxic materials.
4. Must not impair the flow or circulation or reduce the reach of waters of the U.S.
5. Must comply with the 15 federally-required BMPs for roads and skid trails; and follow the 2004 guidance issued by the Corps of Engineers, related to forest road construction.
6. Must comply with the 6 federally-required BMPs for mechanical site prep, if establishing a pine plantation.

Descriptions of Normal Silviculture

The federal regulations and guidance for implementing Section 404 address five primary elements of normal silviculture on forested wetlands:

Forest Product Harvesting [33 CFR 323.4(a)(1)(iii)(B)]

<*start citation*> "Harvesting means physical measures employed directly upon farm, forest, or ranch crops within established agricultural and silvicultural lands to bring about their removal from farm, forest, or ranch land, but does not include the construction of farm, forest, or ranch roads." <*end citation*>

Plowing [33 CFR 323.4(a)(1)(iii)(D)]

Components of site prep that involve soil disturbance are included in the definitions of plowing:

<*start citation*> "Plowing means all forms of primary tillage, including moldboard, chisel, or wide-blade plowing, discing, harrowing, and similar physical means utilized on farm, forest, or ranch land for the breaking up, cutting, turning over, or stirring of soil to prepare it for the planting of crops. The term does not include the redistribution of soil, rock, sand, or other surficial materials in a manner which changes any area of the waters of the United States to dry land. For example, the redistribution of surface materials by blading, grading, or other means to fill in wetland areas is not plowing. Rock crushing activities which result in the loss of natural drainage characteristics, the reduction of water storage and recharge capabilities, or the overburden of natural water filtration capacities do not constitute plowing. Plowing as described above will never involve a discharge of dredged or fill material" <*end citation*>

Cultivating [33 CFR 323.4(a)(1)(iii)(A)]

<*start citation*> "Cultivating means physical methods of soil treatment employed within established farming, ranching and silviculture lands on farm, ranch, or forest crops to aid and improve their growth, quality or yield." <*end citation*>

Bedding and Planting of Seedlings [33 CFR 323.4 (a)(1)(iii)(E)]

<*start citation*> "Seeding means the sowing of seed and placement of seedlings to produce farm, ranch, or forest crops and includes the placement of soil beds for seeds or seedlings on established farm and forest lands." <*end citation*>

Construction and Maintenance of Forest Roads [see 33 CFR 323.4(a)(6)]

Fifteen (15) mandatory BMPs are described in the federal regulations. In addition, road construction in wetlands of North Carolina must adhere to guidance issued by the USACE in 2004; that guidance document is in Appendix 10.

Minor Drainage [33 CFR 323.4(a)(1)(iii)(C)(1)(ii)]

<*start citation*> "Minor drainage means the discharge of dredged or fill material for the purpose of installing ditching or other such water control facilities incidental to planting, cultivating, protecting, or harvesting of rice, cranberries, or other wetland crop species, where these activities and the discharge occur in waters of the United States which are in established use for such agricultural and silvicultural wetland crop production." <*end citation*> (***this is only a partial citation; see Part 8 for more detailed description***).

A Note on Fallow Land

Activities on areas that lay fallow as part of a conventional rotational cycle are still considered to be part of an established operation. However, activities which bring an area into silviculture use are not considered to be an 'established' operation. If wetland has lain idle for so long that modifications to the hydrological regime are necessary to resume operation, then that activity would require a Section 404 permit.

A Note on Altering Vegetation Types in a Wetland

The establishment of non-woody vascular plants, non-native trees, or upland tree species in a wetland for the theoretical intent of "silviculture" is usually not considered to be 'normal, ongoing, and established' and would most likely require a Section 404 permit from the USACE. Consult with the Corps if you intend to establish these types of vegetation in a wetland.

Landowner Responsibilities

Landowners should take care to maintain documentation as evidence of their past, current, and planned future silvicultural activities in wetlands. If the activity is questioned, then this evidence may help to justify that the work is established and ongoing. Some examples may include:

- ✓ A forest management plan.
- ✓ A timeline for future planned silvicultural activities.
- ✓ Enrollment in a forestry Present-Use Value property tax program.
- ✓ Participation in a conservation assistance (cost-share/easement) program.
- ✓ References to the soil survey, noting suitability ratings for woodlands management.
- ✓ Inspection reports and or invoices of past harvesting, road, site prep or other silvicultural work.
- ✓ Historical photographs of past work, and/or aerial photos.
- ✓ On-site evidence of past silvicultural practices.

In addition, **landowners should avoid undertaking activities that are questionable** regarding their relevance to silviculture. Care must be taken to avoid and minimize wetland disturbance. To qualify for the silvicultural exemptions under Section 404, the activity must be related to the establishment, growth, and harvest of timber and forest products. Below are some examples of questionable activities in wetlands that **may require permitting**:

- x Installing a waterfowl impoundment, dike, berm, pond, building, dock, blind, or other structure.
- x Constructing a road or stream crossing that is primarily for a non-silvicultural purpose.
- x Removing or piling topsoil or stumps in a wetland.
- x Ditching in a wetland.
- x Filling of a wetland.
- x Draining a wetland.
- x Installing firebreaks in a wetland for controlled burning that is primarily for wildlife purposes.
- x Clearing wetlands to plant wildlife food plots.
- x Altering a stream (damming or channelizing).
- x Converting from native forest tree species to non-native species or a different vegetation type.

Part 5 -- BMPs for Timber Harvesting in Wetlands

BMPs for All Timber Harvesting in Wetlands:

- Mark sensitive areas on the site where equipment should avoid operating.
- Avoid using heavy equipment on saturated soil or near waterbodies. Cease operations during flooded conditions.
- Concentrate skidding to the primary skid trails and decks. Avoid randomly dispersed equipment traffic on the site.
- Consider ceasing operations or choosing a better harvest method if a single pass of heavy equipment produces ruts deeper than 12-inches across a significant area of the site beyond the primary skid trails and decks.

BMPs for Shovel Logging in Wetlands

- Minimize the number, width, length, and overall footprint of the shovel skid trails. Keep the skid trail to 1-skidder-width wide. If needed for skidders to pass, install a short, wide section of trail.
- Orient the shovel skid trails to prevent restriction of expected flood flows that may occur across the harvest area. Install temporary cross-drains where needed. Do not excavate new ditches.
- Do not install shovel skid trails across streams or surface-water impoundments. If the trail must cross a stream, use temporary bridgemats or log-stringers. If the trail must go across a coastal marsh, first seek guidance from appropriate agency representatives.
- Do not deposit soil atop the shovel skid trail.
- Do not excavate stumps or soil when installing or removing the shovel skid trail.
- Build up the shovel skid trail so that heavy equipment travels above the average soil surface. Minimize operation of rubber-tired machines off the shovel skid trails.
- Add more trees or logs if the shovel skid trail begins to sag, sink or break apart.
  -- The intent is to avoid ‘pumping’ action of the saturated soil from each pass of the skidder, which may increase sedimentation and/or turbidity.
- Promptly remove the shovel skid trail when no longer needed.
  -- The removed logs/trees should be merchandized; or if not usable, then scatter the removed woody material across the site, away from the SMZ.
- Keep the shovel skid trail at least 60 feet from the Streamside Management Zone (SMZ).
- Limit harvesting trees from the SMZ.
  -- Full retention of trees in the SMZ can maximize its ability to restrain visible sediment and moderate stream temperature.

  -- A fully retained SMZ can also provide a long-term seed source, a wildlife habitat corridor, minimize wind-throw potential, and serve as a visual aesthetics screen along the waterway.
- If logging must stop before finishing the harvest, and you wish to keep the shovel skid trail intact to complete the harvest later, then create gaps in the skid trails if there are identifiable flow-ways, so floodwater can pass through.

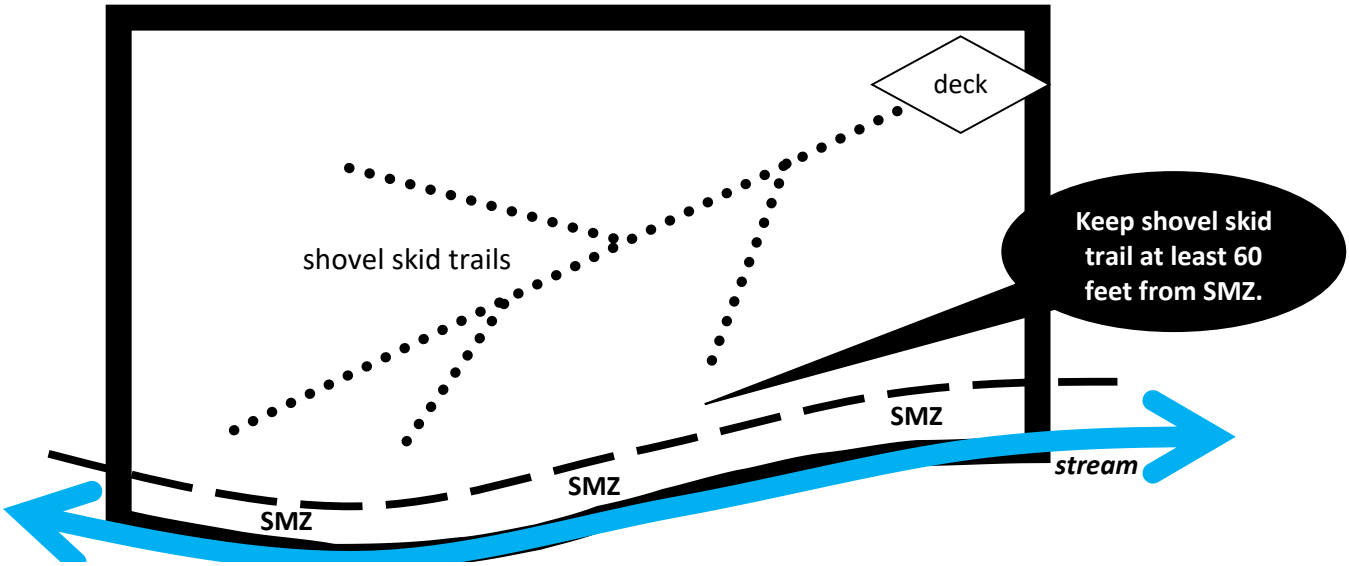


Figure 8A: A hypothetical layout of shovel skid trails to the log deck with 60-feet of space between the skid trail and the SMZ edge

Figure 8B: Aerial view of a recently completed timber harvest using shovel logging methods

Picture note: *This tract was harvested using the shovel logging method. This method reduces the need to construct new logging roads, thereby minimizing potential sedimentation.*
(Image courtesy of Google Earth)

Supplemental Forest Management Considerations for Logging in Bottomland Swamps

- Retain some permanent seed-source trees distributed across the harvest or small clumps/patches of seed source trees. Favor retention of cypress, tupelo, gum, oak or Atlantic white cedar.
- To promote stump sprouting (known as 'coppice'), cut the stumps at or slightly above the normal high-water mark. This mark is often seen as a permanent water stain or moss-line around the base of the trunk. If the stump is submerged underwater, coppice sprouting may be limited.
- Retain snags (if it is safe) and fallen rotten logs to support recruitment of seedlings on hummocks, and to offer wildlife habitat.
- Work with landowners upstream and downstream to promote natural, seasonal stream flows. Take action to prevent water from impounding upon the harvested area while the site regenerates (Examples: beaver dams, man made berms or clogged culverts).

Part 6 -- Forest Roads in Wetlands

Construction of a forest road within or through a wetland is normally associated with timber management and forest products harvesting. Wetlands road construction for another purpose may be not eligible for the Section 404 exemption, and you should consult with the USACE. It is difficult to justify eligibility for the silvicultural exemption when a road is constructed after a timber harvest; or in areas where timber could be harvested using specialized methods (shovel logging); or where small pockets of timber are cut-out such as when excavating ponds, creating impoundments, installing food plots, or conducting other non-silviculture activities.

Temporary and permanent roads constructed in wetlands for forestry purposes are exempt from Section 404 permitting requirements as long as they are constructed in accordance with the mandatory 15 BMPs prescribed in the federal regulations. In North Carolina, forestry roads in wetlands must also:

- ✓ Adhere to the specifications outlined in a 2004 guidance document from the USACE.
- ✓ Comply with the FPGs.
- ✓ Meet the permitting exemption eligibility requirements of the state's CAMA rules and Dredge and Fill Law (if located in a coastal zone county).

15 Federal Mandatory BMPs for Forest Roads

Construction of forest roads, skid trails, and stream crossings in a wetlands or waters of the U.S. -- for the production of forest products -- does not require a Clean Water Act/Section 404 permit as long as the 15 federal baseline provisions (mandatory BMPs) listed below are followed [items (i) through (xv)].

<start citation>

"Construction or maintenance of farm roads, forest roads, or temporary roads for moving mining equipment, where such roads are constructed and maintained in accordance with best management practices (BMPs) to assure that flow and circulation patterns and chemical and biological characteristics of waters of the United States are not impaired, that the reach of the waters of the United States is not reduced, and that any adverse effect on the aquatic environment will be otherwise minimized. These BMPs which must be applied to satisfy this provision shall include those detailed BMPs described in the state's approved program description pursuant to the requirements of 40 CFR Part 233.22(i), and shall also include the following baseline provisions:

(i) Permanent roads (for farming or forestry activities), temporary access roads (for mining, forestry, or farm purposes) and skid trails (for logging) in waters of the U.S. shall be held to the minimum feasible number, width, and total length consistent with the purpose of specific farming, silvicultural or mining operations, and local topographic and climatic conditions;

(ii) All roads, temporary or permanent, shall be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) to minimize discharges of dredged or fill material into waters of the U.S.;

(iii) The road fill shall be bridged, culverted, or otherwise designed to prevent the restriction of expected flood flows;

(iv) The fill shall be properly stabilized and maintained during and following construction to prevent erosion;

(v) Discharges of dredged or fill material into waters of the United States to construct a road fill shall be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers, or other heavy equipment within waters of the United States (including adjacent wetlands) that lie outside the lateral boundaries of the fill itself;

(vi) In designing, constructing, and maintaining roads, vegetative disturbance in the waters of the U.S. shall be kept to a minimum;

(vii) The design, construction and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body;

(viii) Borrow material shall be taken from upland sources whenever feasible;

(ix) The discharge shall not take, or jeopardize the continued existence of, a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species;

(x) Discharges into breeding and nesting areas for migratory waterfowl, spawning areas, and wetlands shall be avoided if practical alternatives exist;

(xi) The discharge shall not be located in the proximity of a public water supply intake;

(xii) The discharge shall not occur in areas of concentrated shellfish production;

(xiii) The discharge shall not occur in a component of the National Wild and Scenic River System;

(xiv) The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts; and

(xv) All temporary fills shall be removed in their entirety and the area restored to its original elevation." *<end citation>*

A Note on Item (x), "practical alternatives"

Impacts should be avoided if practical alternative exist. This may include building the road in uplands, deploying harvesting methods that do not need roads (such as shovel logging), or waiting until the site is relatively dry to conduct the activity.

A Note on Item (xiii), National Wild and Scenic Rivers

North Carolina contains five segments of rivers designated as a National Wild and Scenic River: Chattooga River; Horsepasture River; New River (in the mountains); Lumber River; and Wilson Creek. These river segments are described at *www.rivers.gov*.

2004 Required Guidance for Constructing Exempt Forest Roads in Wetlands of NC

With cooperation from forest industry, the NCFS and the USACE, a guidance document was produced in 2004 by the USACE Wilmington District entitled "*Information Regarding Compliance with the Federal Clean Water Act Section 404(f)(1) Provisions for the Construction of Forest Roads Within Wetlands, in North Carolina*." This document contains guidance for road system planning and generally-accepted specifications for road lengths, widths, spacing and height of road fill above the ground surface. This document is in Appendix 10 and available from the NCFS website. It may be presumed that maintaining the Section 404 exemption is contingent upon adhering to the guidance in this information document.

A Note About Borrow Ditches

If constructing a new forest road in a wetland, an adjoining parallel borrow ditch is allowable to obtain road fill material. But, to qualify for the Section 404 exemption, the borrow ditch must not connect to an outlet. The ditch must dead-end on both ends, with an unexcavated natural break. The length of this natural break is dependent on soils and must be long/wide enough to preclude water from draining through and/or over the break. In some cases a break of 150 feet or more may be required.

Additional Supplemental BMPs for Forest Roads in Wetlands

- Construct roads during periods of relatively dry soil conditions.
- For temporary access, use logging road pallet mats instead of backfill, where appropriate.
- Keep the roadbed height profile as low as feasible, while meeting the needs for vehicle access.
- If building a fill road, provide ample cross-drainage to avoid impounding and to allow flood-flows during storms. Multiple cross drains are usually needed, even for a short section of fill road.
- Use cross drain culverts of at least 18 inches diameter.
  -- Review the applicability of BMPs for culvert stream crossings in Chapter 6.
- If building a flat road, give preference to installing a hard-bottomed, dry-ford at locations where natural flow-ways of floodwater are likely to cross the road during storms.
- At culvert waterway crossings, consider incorporating shallow dips in the road approachways on both sides of the culvert crossing, so floodwaters can bypass up and around the pipe during storms.
- As needed, apply gravel to harden the road surface atop culverts and within flow-bypass dips.
- Promptly apply groundcover to stabilize the road shoulders and backfill.
- If appropriate, install and maintain a shallow grader-ditch or a knee-berm along the roadside edges to control rainwater runoff and allow sediment to settle.
- Stabilize the roadway surface and maintain it for erosion and sedimentation control.
  -- On permanent roads, gravel or other suitable aggregate usually works best.
  -- On temporary roads, ample grass/groundcover vegetation may be sufficient.
- Avoid using backfill or surfacing aggregate material that contains asphalt or live cement.
- Maintain a daylight corridor along the roadway to allow sunlight exposure that can dry-out the road and minimize the potential for muddy water runoff.
  -- A general rule-of-thumb is for the daylight strip on either side to be approximately one-half of the total road width. For example, if the road is 20 feet wide, the daylight strip on either side would be about 10 feet wide.

Figure 8C: A forest road constructed through a wetland

Picture note: *Geotextile was used to build this forest road through wetlands. This type of minimum-standard road is usually adequate for most forest landowners. The road is low-profile, stabilized with gravel, and only as wide as needed. No ditches were dug to build this section of road.*

Part 7 -- Site Prep in Wetlands

Site Preparation (site prep) is the term used to describe activities to prepare a site for forest tree regeneration. There are 6 required BMPs for mechanical site prep when establishing pine plantations in wetlands of the southeastern U.S. These 6 BMPs are outlined in a joint agency *Memorandum to the Field* dated November 28, 1995 issued by USEPA and USACE. While the memorandum is available in Appendix 10, the required 6 BMPs are outlined in this section.

When a Permit is Required

The 1995 *Memorandum to the Field* explains that a Section 404 permit is required to conduct mechanical site prep for establishing a pine plantation within nine types of wetlands in the Southeast.
The nine wetland types that may require a permit to mechanically site prep are:

1. Permanently flooded, intermittently exposed, and semi-permanently flooded wetlands.
2. Riverine Bottomland Hardwood wetlands.
3. White Cedar Swamps.
4. Carolina Bay wetlands.
5. Non-riverine Forest wetlands.
6. Low Pocosin wetlands.
7. Wet Marl Forests.
8. Tidal Freshwater Marshes.
9. Maritime Grasslands, Shrub Swamps, and Swamp Forests.

The *Memorandum* in Appendix 10 briefly describes each wetland type, to help recognize them.

Federal Mandatory BMPs for Mechanical Site Prep

There are 6 required BMPs cited below for reference:

<start citation> "…The following forested wetlands BMPs are designed to minimize the impacts associated with mechanical silvicultural site preparation activities in circumstances where these activities do not require a permit (authorization from the Corps is necessary for discharges associated with silvicultural site preparation in wetlands described above as requiring a permit.) The BMPs include, at a minimum, the following:

1) position shear blades or rakes at or near the soil surface and windrow, pile, and otherwise move logs and logging debris by methods that minimize dragging or pushing through the soil to minimize soil disturbance associated with shearing, raking, and moving trees, stumps, brush, and other unwanted vegetation;

2) conduct activities in such a manner as to avoid excessive soil compaction and maintain soil tilth;

3) arrange windrows in such a manner as to limit erosion, overland flow, and runoff;

4) prevent disposal or storage of logs or logging debris in streamside management zones -- defined areas adjacent to streams, lakes, and other waterbodies -- to protect water quality;

5) maintain the natural contour of the site and ensure that activities do not immediately or gradually convert the wetland to a non-wetland; and

6) conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts." *<end citation>*

Additional Supplemental BMPs for Mechanical Site Prep in Wetlands

- Consider alternative silvicultural prescriptions that do not require mechanical site prep.
- Limit site prep to only where needed to facilitate successful reforestation.
  -- Use methods that minimize overall wetland disturbance. See Ch. 9 for Site Prep BMPs.
- Site prep when soil is relatively dry. Minimize work on saturated soils.
- Stay back at least 50 feet from the edge of a stream, marsh, or other natural waterbody.
- Avoid filling-in wet, depressional areas or natural flow-ways. Maintain natural topography.
- Avoid crossing streams whenever possible. See Ch.6 for Stream Crossing BMPs.
- When crossing a ditch with heavy equipment, promptly remove the crossing when no longer needed. Stabilize the ditch banks for erosion and sedimentation control as soon as possible.
- When leaving gap openings in beds or windrows, stagger the openings from one row to the next, to minimize the funneling of surface runoff but still allowing overland sheetflow to pass; this is especially important in low-lying flood-prone areas.
- Minimize site prep along ditches, in order to maintain structural integrity of the ditch bank.

A Note on Stump Removal

The removal of stumps (either fresh stumps or old 'fat-lightered' pine rosin stumps) may not be an exempt activity under Section 404. You should consult with the Corps of Engineers if you intend to remove stumps in a forested wetland, when not associated with construction of a road or log deck.

A Note on Deep Ripping of Soil

Deep ripping of soil (interpreted as greater than 16 inches deep) is not an exempt activity if it is required to establish silviculture for the first time or if it breaks up a restrictive soil layer that results in significant drainage that immediately or gradually converts a wetland to a non-wetland.

Part 8 -- Minor Drainage

DISCLAIMER: This section outlines certain federal requirements related to silvicultural minor drainage. The BMPs for Minor Drainage included in this manual are not an endorsement of the practice of minor drainage. The recommendations in this section provide BMPs for minor drainage to help facilitate compliance with North Carolina's FPG standards. Forest owners and operators are advised to consult with the USACE before installing minor drainage or conducting ditch maintenance.

<<< Helpful Hint >>> Minor drainage for silviculture is usually only needed on Very Poorly Drained soils and on some Poorly Drained soils, most of which are hydric and many of which are jurisdictional wetlands. When conducted, it is most often used for the cultivation of pine species and rarely used to cultivate cypress, juniper or hardwood species.

<<< Helpful Hint >>> In practice, minor drainage can be considered as minimal or superficial drainage needed to harvest, regenerate, and manage a forest tree stand.

Regulatory Descriptions of Minor Drainage

Below are two excerpts from the federal rules describing minor drainage, in the context of silviculture:

33 CFR 323.4(a)(1)(iii)(C)(1)(ii), "Minor Drainage" means:

<*start citation*> "The discharge of dredged or fill material for the purpose of installing ditching or other such water control facilities incidental to planting, cultivating, protecting, or harvesting of rice, cranberries or other wetland crop species, where these activities and the discharge occur in waters of the United States which are in established use for such agricultural and silvicultural wetland crop production;"… <*end citation*>

33 CFR 323.4(a)(1)(iii)(C)(2):

<*start citation*> "Minor drainage in waters of the U.S. is limited to drainage within areas that are part of an established farming or silviculture operation. It does not include drainage associated with the immediate or gradual conversion of a wetland to a non-wetland (e.g., wetland species to upland species not typically adapted to life in saturated soil conditions), or conversion from one wetland use to another (for example, silviculture to farming). In addition, minor drainage does not include the construction of any canal, ditch, dike or other waterway or structure which drains or otherwise significantly modifies a stream, lake, swamp, bog or any other wetland or aquatic area constituting waters of the United States. Any discharge of dredged or fill material into the waters of the United States incidental to the construction of any such structure or waterway requires a permit." <*end citation*>

Recapture Provision

The generally-accepted term of 'recapture' means that the Section 404 silviculture exemption is lost and the site becomes subject to the permitting requirements of the Clean Water Act for discharging or dredging fill material into a water of the U.S. According to these provisions, 'recapture' can occur:

- If the purpose of such dredging or discharge is part of an activity whose purpose is to convert an area of the waters of the U.S. into a use to which it was not previously subject, (such as converting a forest to non-forest, or changing species); **or**,
- Where the flow or circulation of waters of the U.S. may be impaired or the reach of such waters reduced, (such as impounding water or converting a wetland to non-wetland).

For the full description about 'recapture', reference 33 CFR 323.4(c).

To maintain the Section 404 silviculture exemption on an intensively managed forest stand that has minor drainage (on a site that was jurisdictional wetland before installation of the minor drainage), that site must continue to meet the hydrophytic vegetation, hydric soils, and hydrology criteria for a jurisdictional wetland, even after minor drainage is installed.

BMPs for Planning Minor Drainage

- Consider alternative silvicultural prescriptions that do not require minor drainage. Examples include establishing native wetland tree species, or using alternative methods for timber harvesting (shovel logging) and/or site prep (bedding).
- Limit minor drainage to only where absolutely needed on the site to facilitate successful forest management.
- Document your decision-making process and resources that you referenced, if you elect to proceed with installing minor drainage. If there are reservations or questions about the suitability of minor drainage for your site, then consult with the Corps of Engineers.

BMPs for Installing Minor Drainage

- Conduct excavation and maintenance during periods of relatively dry soil.
  -- If the new minor drainage feature is expected to be deeper than 12 inches or will directly, physically connect to an outlet, then you should first seek advice from the Corps of Engineers.
- Minimize removal of tree stumps.
  -- Cut the tree/stump at ground level and retain the stump/rootwad intact to provide anchoring for the channel and to limit soil disturbance.
- When installing new minor drainage, start excavation near the discharge end while leaving a plug of soil in place to serve as a temporary dam in the newly excavated ditch.
  -- This soil plug allows settling-out of sediment before connecting the new ditch with an existing drainage outlet.
- Deposit excavated material/spoil within 20 feet of its origin (Be aware: This is a state of North Carolina rule requirement).
- Keep spoil piles small with frequent gaps between them to minimize blockage of floodwaters.
- Stabilize the spoil material for erosion and sedimentation control.
- After completing new excavation, stabilize exposed soil in the ditch channel and along the ditchbanks for a distance of 50 feet from the outlet, if there is one.
  -- Examples include seed and straw, erosion control matting, excelsior/straw wattles, coconut/coir logs, straw/hay bales, hydroseeding and/or check dams.

BMPs for Ditch Maintenance

- Conduct maintenance during periods of relatively dry soil.
- Minimize the excavation or pushing of trees.
  -- Cut the tree/stump at ground level and retain the stump/rootwad intact to provide anchoring for the channel and to limit soil disturbance.
- Install temporary check dams in the ditch to allow visible sediment to settle out before the ditch outlet, if there is one.
- Only remove accumulated material down to the ditch's original dimension (depth, width, length).
- Deposit excavated material (spoil) atop existing adjacent roads or on top of old spoil.
  -- North Carolina rules require that spoil be placed within 20 feet of its origin.
- Keep spoil piles small with frequent gaps between them to minimize blockage of floodwaters.
- Stabilize the spoil material for erosion and sedimentation control.
- After completing maintenance, stabilize exposed soil in the ditch channel and along the ditchbanks for a distance of 50 feet from the outlet.
  -- Examples include seed and straw, erosion control matting, excelsior/straw wattles, coconut/coir logs, straw/hay bales, hydroseeding and/or check dams.

<<< Helpful Hint >>> In addition to these BMPs, review the guidance memo issued by the EPA & USACE in July 2020; see Appendix 10. That memo includes information about maintaining eligibility for the Section 404 exemptions while conducting ditch maintenance.

A Note on Historical Drainage Practices

Many ditches in a large portion of drained pine plantations under management today in coastal North Carolina were constructed from the 1950s through the 1980s, before those sites came under the protection of the Clean Water Act and/or state wetland protection rules. This note is only offered as a reference so that you can be aware of what you may see in the woods, as a legacy of past impacts.

Historically, roadside ditches next to permanent roads were often called 'collector ditches' and served multiple functions:

- Provided fill for building the road.
- Provided a hydraulic gradient from the lateral in-woods ditches, to promote drainage.
- Transported drainage discharge to a stream outlet.
- Drained the roadbed to facilitate all-weather use.

Historically, there were many methods employed to drain a site:

Stream Channelization: Streams were dug-out to be deeper, straighter, and wider to drain the land faster. Today, these channelized streams may look like ditches, but they are still considered to be streams, and therefore require protection, such as establishing a SMZ and/or a river basin & watershed Riparian Buffer Rule zone where applicable (see Ch. 2).

Pattern Drainage: Ditches were installed in a regularly-spaced parallel, block-grid, or herringbone-style pattern. They were commonly installed upon large areas of very flat terrain containing hydric soils (such as broad interstream divides, wet pine flats/pine flatwoods, and some pocosins).

Ring (Perimeter) Ditch: A ditch would be dug around the perimeter of a tract and connected to an outlet.

Tulloch Ditch: Ditches were dug and the spoil material was removed off-site.

Be Aware **>>> Today, all of these historical practices most likely DO NOT COMPLY with current regulatory interpretations of exempted minor drainage under Section 404 of the Clean Water Act. Do not undertake any of these practices until first consulting with the U.S. Army Corps of Engineers.**

Chapter 9: Forest Management

Forest management operations influence water quality. The extent of influence depends upon many factors. The information contained in this chapter should reduce potential water quality impacts. For definitions of forestry terms and descriptions of common forest management practices, consult the series of Forest Management ('FM') *Forestry Leaflets* available from the NCFS website.

Part 1 -- Forest Management Chemicals

Chemicals used in forestry generally are fertilizers or pesticides. Pesticides include: herbicides (plants), insecticides (insects), rodenticides (rodents), and fungicides (fungus, mold). The careful prescription and application of select chemicals can enhance forest growth and health in a number of ways:

- Controlling harmful, undesirable or invasive/exotic species.
- Reducing wildfire risks.
- Improving soil nutrition.

In most cases, there are federal and/or state rules that describe actions to take for proper chemical use. This information should be available on the product's label and/or Safety Data Sheets (SDS). Labels also alert you to protective equipment needs, mixing instructions, wind speed, temperature limitations, first aid procedures, and other useful information.

When applying chemicals, it is necessary to take precautions so water quality is protected. For many chemicals used in forestry, it is illegal to apply them to water, or allow them to be washed into waterbodies. Only those chemicals labeled for aquatic use may be applied over or into waterbodies.

Rules Related to Using Forestry Chemicals in North Carolina

Forest Practices Guidelines Related to Water Quality (FPGs)

There are nine performance standards for forestry operations, that if followed, provide for exemption of those operations from the permitting requirements of the N.C. Sedimentation Pollution Control Act. FPG rules .0205, .0206 and .0207 specifically are related to chemicals.

DWR/EMC river basin and watershed 'riparian buffer rules'

-- Restricts the use of pesticides and fertilizers within the buffer.
-- Consult each rule for your specific river basin or watershed.

Pesticide Applicator Licensing Requirement

02 NCAC 09L .0503 through .0519 defines who is allowed to apply pesticides and what procedures they must follow to be licensed.

Aerial Application of Pesticides

02 NCAC 09L .1001 through .1005 defines rules related to aerial application of pesticides, including restricted areas.

N.C. Pesticide General Permit #NCG560000 under the NPDES

This permit may be required when aerially applying pesticides over wetlands and streams.

Site and Chemical Factors to Consider

Protecting water quality must be considered when using forestry chemicals. When planning their use, it is important to learn the characteristics of the chemicals to be used. It is necessary to take into account site factors such as topography, soil conditions, drainage and other factors to adequately protect water quality. Two important chemical characteristics are explained below.

1. **Mobility:** The ability of the chemical to move through the soil and environment. A chemical that has high mobility may easily move off-site.
2. **Persistence:** The length of time a chemical remains active after application. A chemical with long duration persistence may have long-lasting effects once it is applied.

BMPs for Forest Management Chemicals

- Refer to the product's label(s) and/or SDS for specific requirements.
- Properly store, mix, and load chemicals away from SMZs, ditches and waterbodies.
- Properly dispose chemical containers according to product label recommendations and laws.
- Park equipment used for application outside of the SMZ or away from water.
- Plan for the containment and cleanup of spills or leaks by having suitable tools or materials on-site.
- Avoid broadcast-style of application within or over SMZs and water, unless the chemical to be applied is labeled for aquatic use.
- Apply at least 50 feet away from an intermittent or perennial stream or perennial waterbody, unless the targeted area falls within this distance range. Take precautions to protect water quality if applied closer than this.
- Apply fertilizer sparingly in ephemeral drainages.
- Avoid chemical application if rainfall is forecast within the following 24 hours.

Emergency, Toxic Exposure and Spill Contacts

Personal Health and Safety - - Call 911 for immediate life-saving help.

NC Poison Control 1-800-222-1222 www.ncpoisoncontrol.org

Spill Control and Notification NCDEQ Regional Offices:

Asheville	(828) 296-4500	Washington	(252) 946-6481
Fayetteville	(910) 433-3300	Wilmington	(910) 796-7215
Mooresville	(704) 663-1699	Winston-Salem	(336) 776-9800
Raleigh	(919) 791-4200		

N.C. Division of Emergency Management 24-hour HotLine
1-800-858-0368

National Response Center (24-hours)
1-800-424-8802 www.nrc.uscg.mil/nrchp.html

Pesticide Rules -- N.C. Dept. of Agriculture and Consumer Services, Pesticide Section:
(919) 733-3556 www.ncagr.gov/SPCAP/pesticides/Authorit.htm

Pesticide Information, National Pesticides Information Center
1-800-858-7378 http://npic.orst.edu/

Part 2 -- Equipment Fluids and Solid Waste

Careful management of fluids and solid waste during forestry operations is needed to protect water quality. Some ways to achieve water quality protection include:

1. **Control fluids to prevent them from entering the ground and water.**
   This includes maintaining equipment, preparing for spills, and properly disposing used materials.
2. **Collect and dispose of trash and other wastes.**
   This keeps waste from being washed into the water if left on the job site

<<< Helpful Hint >>> The BMPs in this manual focus on protecting water resources. There may be other laws and requirements related to the labeling, storage, and safe handling of petroleum, fluids and solid waste.

State Requirements for Notification of a Petroleum Spill

[cited from state law, GS 143-215.85(b)]

Notify NCDEQ / DWR within 24 hours of discharge or spill if:

- Amount is 25 gallons or more, or
- Spill causes a sheen on nearby surface water, or
- Spill occurs within 100 feet of any surface water.

No notification is needed, but cleanup must still occur if:

- Amount is less than 25 gallons, and
- No sheen is produced on nearby surface water, and
- The spill is located more than 100 feet from surface water.

Notify NCDEQ / DWR immediately if:

- Amount is less than 25 gallons, and
- You cannot effectively clean it up within 24-hours of spill, or
- Spill causes a sheen on surface water.

Regardless of the amount of a spill, state law requires immediate action to control, contain, and remove the spilled fluid.

Spill Control and Notification NCDEQ Regional Offices:
Asheville (828) 296-4500. Fayetteville (910) 433-3300. Mooresville (704) 663-1699.
Raleigh (919) 791-4200. Washington (252) 946-6481. Wilmington (910) 796-7215.
Winston-Salem (336) 776-9800.

N.C. Division of Emergency Management 24-hour HotLine: 1-800-858-0368

National Response Center (24-hours): 1-800-424-8802 www.nrc.uscg.mil/nrchp.html

BMPs for a Fluid Spill

- Control the spill, stop the leak, keep fluid from discharging.
- Contain the fluid.
  -- Create a temporary dirt berm or dike around the spill.
  -- Apply absorbent material to soak-up the fluid (ex: sawdust, wood chips, oil-dry, cat litter, etc.)
- Contact NCDEQ for guidance on cleanup and disposal.

BMPs for Managing Fluids

- Keep fluids away from waterbodies.
- Frequently inspect equipment for leaks and repair them promptly, especially working near water.
- When washing equipment in the woods, only use water. Do not use degreasers or detergents.
- Designate areas for equipment maintenance and fueling on level ground away from water.
- Park and service equipment at least 100 feet from all streams, wetlands, ditches, and ephemeral drainages if site conditions allow.
- Maintain tools and materials to contain and clean up spills and leaks. Examples include:
  -- A variety of plugs and clamps to control a hose leak.
  -- Containers (with lids) to catch and contain leaking fluid.
  -- Shovels and absorbent material or pads (booms) to soak up fluids.
  -- Plastic sheeting or tarp to create a barrier on top of the soil.
- Use suitable secured containers with lids to store oils, fuels and other fluids in way that controls or minimizes leakage and spillage.

<<< Helpful Hint >>> Preventing leaks and spills is usually less expense and faster than cleaning a spill. Ignoring a leak or spill, and treating it as normal business, is not acceptable. Petroleum and other material can be disposed and recycled at vendors around the state. Reference Appendix 7 to see the state's website for lists of vendors at, www.p2pays.org ("Recycling Market Directory").

Photo 9A: A trailer used for holding fluid containers on a logging job

***Picture note**: An equipment trailer can be used to securely store fluid containers out of the way from vehicles and tractors. Even if a trailer is not used, keep containers in a central and secure location away from streams.*

BMPs for Solid Waste Management

- Do not bury or burn fluid containers, tires, trash or other waste on the job site. The remnants may wash into nearby waterbodies creating pollution problems.
- Keep garbage in a container for proper disposal. If left uncontrolled, garbage and waste may pose a risk to water quality.

Part 3 -- Fire Management

Fire is a natural element of North Carolina's landscape, including pine and hardwood forests. Prescribed burning is a silvicultural practice that can support reforestation, vegetation control, species habitat, wildfire hazard reduction, and ecological restoration. Using fire as a management tool may reduce soil disturbance that might otherwise result from using heavy equipment to accomplish the same task.

The most frequent water quality concern associated with fire is accelerated erosion and sedimentation from firelines. However, if a fire burns too hot (as happens on some wildfires) the soil's organic matter (duff layer) can be completely burned off, exposing mineral soil, and creating an erosion risk.

<<< Helpful Hint >>> Some ephemeral wetlands and many riparian areas can benefit from periodic, low-intensity prescribed fire. In those cases, a plowed or bladed firebreak may not be needed if the fire can be allowed to burn through the wetland or stream.

Rules Related to Fire Management in North Carolina

Forest Practices Guidelines Related to Water Quality (FPGs)

There are nine performance standards for forestry operations, that if followed, provide for exemption of those operations from the permitting requirements of the N.C. Sedimentation Pollution Control Act.

North Carolina General Statute 77-13 and General Statute 77-14

Prohibits obstructing streams, waterways, and ditches.

DWR/EMC river basin and watershed 'riparian buffer rules'

These rules restrict certain site prep activities within the buffer zones. Consult each rule for your specific river basin or watershed.

Regulation of Open Fires [G.S.106-940 through 106-950]

Sets criteria for when and where burning permits are required.

North Carolina Prescribed Burning Act [G.S. Ch.106-965 through 106-970]

If you choose to follow the guidance defined by this Act, you must obtain a burn plan that is prepared by a certified burner, file it with the NCFS, and burn according to the parameters in the plan.

Planning a Prescribed Burn

The burn plan should include descriptions of BMPs to conserve soil and protect water quality. Factors to consider include the following:

Groundcover:	If appropriate for the burn's objectives, retain some duff to absorb rainfall.
Slope:	Steeper slopes require more measures to control runoff after the fire.
Rainfall:	Heavy rainfall after the fire can dislodge and wash away exposed soil.
Soil:	Some soils are more prone to erosion than others.
Firelines:	Minimize overall soil disturbance, and rehabilitate promptly afterward.

BMPs for Planning and Burning

- Retain some duff layer to absorb rainfall and runoff, if possible, while meeting the burn objectives.
- Use existing firebreaks when possible to avoid disturbing the soil. Examples include streams, ponds, wetlands, roads, canals, utility corridors, etc.
- Consider installing firelines that do not require plowing or blading the soil. Examples include mulching/grinding, disking, mowing, matting vegetation, leaf-blowers, or wet-lines.

Firelines for Prescribed Burning

In most cases, only the top layer of vegetation (fuel) needs to be removed. Stumps usually do not need to be pushed-out of the fireline. If the fireline will be used afterward for access or future burns, then permanent water diversions should be incorporated into the fireline, similar to a logging skid trail.

Consider allowing the fire to back-out from the stream and burn through the SMZ, thereby avoiding the need to install a fireline along the SMZ. A fireline in the transitional eco-tone between uplands and the riparian area can block movement of amphibians and other wildlife. Installing a fireline near the SMZ or stream will often result in more environmental risk than the effects from the prescribed fire.

Figure 9B: A well-done bladed fire control line for a site prep burn

Picture note: *Only enough vegetation was scraped off the surface to create a fire break. Excessive digging, plowing, and pushing of soil is usually not needed for a temporary fire break.*

BMPs for Firelines on Prescribed Burns

- Install the fireline only as deep and/or wide as necessary to contain the prescribed fire.
- Minimize erosion and prevent runoff from directly entering waterbodies. Install water diversions.
- Set the fireline along the contour. Avoid straight uphill/downhill placement when possible.
- Fireline slope should be kept to 25% or less if possible.
- Stay out of marsh areas.
- Promptly remove debris or soil that was deposited into a stream during fireline installation.
- Revegetate exposed soil in firelines where needed to control erosion.

Wildfire Control

During a wildfire, firefighters work aggressively to protect life, property and natural resources. Site rehabilitation and soil stabilization after a wildfire includes the deployment of BMPs; but this is usually done after the wildfire is contained, controlled or extinguished.

BMPs for Wildfire Control

- Protect surface waters from sedimentation and polluted runoff.
- Minimize the number of stream crossings. Promptly rehabilitate them afterward.
- Keep fire-retardant chemicals out of surface waters whenever possible.
- Clean and maintain firefighting equipment away from surface waters.
- If water retention areas are constructed, return them to their preexisting condition afterward.
- Stabilize and/or retire firelines, trails, or roads. Install water diversions.
- Establish groundcover, re-vegetate or stabilize areas that are a high risk of accelerated erosion.

Part 4 -- Site Preparation and Reforestation

Trees vary in their requirements for sunlight and soil resources to successfully regenerate. This includes most of North Carolina's commercially valuable trees, as well as those valued for wildlife, recreation and visual beauty. Site preparation ("site prep") accomplishes one or more of the following objectives:

- Creates soil conditions for successful natural regeneration or tree planting.
- Promotes tree seedling survival by reducing plant competition for nutrients, water and sunlight.
- Improves soil moisture conditions.
- Makes tree planting easier by reducing or eliminating unusable debris.
- Enhances food and habitat conditions for certain wildlife species.
- Reduces wildfire hazards and improves access for firefighting.

There are many methods of site prep. This chapter focuses on BMPs for mechanical site prep, in which heavy equipment is used and soil disturbance occurs.

Rules Related to Site Prep for Forest Management

Forest Practices Guidelines Related to Water Quality (FPGs)
There are nine performance standards for forestry operations, that if followed, provide for exemption of those operations from the permitting requirements of the N.C. Sedimentation Pollution Control Act.

North Carolina General Statute 77-13 and General Statute 77-14
Prohibits obstructing streams, waterways, and ditches.

DWR/EMC river basin and watershed 'riparian buffer rules'
These rules restrict certain mechanical site prep within the buffer zones. Consult each rule for details.

North Carolina Dredge and Fill Law
This state law requires that permits be secured for discharges of dredged or fill material in certain locations within the 20 CAMA counties; see Chapter 8.

U.S. Army Corps of Engineers / EPA Memorandum to the Field Related to the Silviculture Exemption (Mechanical Site Prep BMPs for Pine Plantations on Wetlands of the Southeast).
There are six federally-required BMPs for mechanical site prep in wetlands; see Chapter 8.

Mechanical Site Prep and Reforestation Methods

The mechanical site prep methods identified in this manual are commonly used for forest management in North Carolina, either by themselves or coupled together. This manual is not recommending the use of any specific site prep method, but is providing BMPs for when these practices are employed.

Prescribed Fire: Removes leftover woody debris, opening up the site for seedfall, soil preparation or tree planting. See previous section in this chapter.

Shearing/Raking/Piling: Concentrates woody debris into piles, opening up the site for further site prep, reforestation or allowing piles to be burned more easily.

Mulching/Grinding: Leftover trees and/or debris are shredded and mulched in-place, as an alternative to shearing/raking/piling.

Drum Chopping: Knocks down leftover trees and breaks apart woody debris, accelerating its decomposition and improving conditions for burning or herbicide application.

Tilling/Disking: Breaks up hardened or compacted soil to improve root growth of new seedlings and infiltration of runoff.

Bedding: Creates raised linear beds for tree seedlings to be planted within, usually in wet soils. Can also help control competing vegetation.

Lopping: Leftover standing trees are felled by hand.

Tree Planting: Seedlings can be planted by hand or with tractor-mounted apparatus.

Site prep should accomplish silvicultural objectives while minimizing negative impacts to the soil, organic matter, and hydrology. A site prep or 'regen' (regeneration) plan should be developed to outline BMPs and identify sensitive areas to avoid, such as streams and waterbodies. More information on site prep is found in the Forest Management ('FM') series of NCFS *Forestry Leaflets*, available from www.ncforestservice.gov.

BMPs for Mechanical Site Prep

- Operate heavy equipment when soil is relatively dry. Avoid working saturated soil.
- Minimize exposure of bare soil, especially on areas with high erosion risk or near waterbodies.
- The site prep should not significantly reduce the infiltration capacity of the soil.
- Avoid uprooting of stumps and trees where possible.
- Stay out of the SMZ.
- Minimize overall site disturbance within ephemeral drainages.
- Maintain the natural topography of the land; avoid filling-in or leveling-off areas.
- Avoid gouging the soil in a manner that could funnel runoff and deliver sediment into waterbodies.
- Minimize the number of passes of heavy equipment across the site.
- Service equipment away from waterbodies and the SMZ.

Additional BMPs for Shearing/Raking/Piling:

- Minimize displacement of topsoil. A toothed-rake often works better than a dozer blade.
- Arrange windrows along the contours across the slope, not up and down the slope.
- Leave opening in windrows to avoid impounding surface water runoff. Stagger the openings from one windrow to the next.
- Avoid pushing debris into the SMZ.

Additional BMPs for Bedding and Tilling/Disking:

- Operate along the land contour across the slope, not up and down the slope.
- Do not aim bed rows or tillage strips downslope or towards a stream.
- Retain undisturbed groundcover between bed rows and tillage strips.
- Do not tie-in with intermittent or perennial streams, ditches or perennial waterbodies.
- When leaving gap openings within bed rows, stagger the openings from one bed row to the next, to minimize the funneling of surface runoff but still allowing overland sheetflow to pass. This is especially important in low-lying flood-prone areas.

Figure 9C: Ground-level view of a freshly pulled bed

***Picture note**: An un-bedded strip is retained (on the right). Work was done when soil moisture was appropriate, and not too wet.*

Figure 9D: Bulldozer pulling a drum chopper
***Picture note**: The soil is dry enough to support the equipment with no rutting.*

Figure 9E: Bulldozer with a toothed root rake piling debris
***Picture note**: Groundcover duff layer remained intact after raking.*

Figure 9F: Bulldozer with a V-blade pushing debris aside for bedding
***Picture note**: Only the large surface debris is moved aside, not the groundcover duff layer.*

Chapter 10: Site Rehabilitation and Stabilization

Site rehabilitation (site rehab) includes actions to conserve soil and protect water quality once operations are concluding in an area of the tract. These actions may include stabilization of soil, loosening of compacted or rutted soil, controlling runoff, adding soil amendments and applying groundcover.

Other names may be used to describe this process, such as: retiring, closing-out, or putting to bed.

Allowing a site to simply naturally revegetate usually is not enough on critical areas that may be prone to accelerated erosion or near waterbodies. The state FPGs require site rehabilitation.

Figure 10A: Stream crossing after completion of logging

Picture note: *Debris was removed. Silt fence and waterbars were installed to divert runoff away from the stream. Groundcover stabilization vegetation was established.*

Rules Related to Site Rehab

Forest Practices Guidelines Related to Water Quality (FPGs)

There are nine performance standards for forestry operations, that if followed, provide for exemption of those operations from the permitting requirements of the N.C. Sedimentation Pollution Control Act. The FPG rules .0203 and .0209 include requirements for site stabilization and rehab.

North Carolina General Statute 77-13 and General Statute 77-14

Prohibits obstructing streams, waterways, and ditches.

DWR/EMC river basin and watershed 'riparian buffer rules'

These rules require restoration of disturbed areas within the buffer zones. Consult each rule.

Planning Site Rehab

Runoff after rainfall may wash sediment and other pollutants into water at any time during a forestry operation. Because of this, it is important to consider site rehab and stabilization before, during and after forestry activities. For example, if a portion of a harvest site is completed and no other activities will be conducted on that portion, site rehab can be accomplished right away in that area, instead of waiting until the end of the entire harvest job. Recent studies have demonstrated that prompt and effective soil stabilization and groundcover are critical to comply with the FPGs and conserve soil.

<<< Helpful Hint >>> Many low-cost and easy-to-install rehab and stabilization methods have proven to be equally effective as other methods that are more labor-intensive and expensive.

The most common places that likely will need rehab include crossings, roads, skid trails, decks, and firelines. The landowner's management goals can influence the type of practices to use for rehabilitating and stabilizing the site, with some examples listed below:

- Temporary roads or skid trails may be retired by installing waterbars and brush, but permanent roads may need rolling dips, turnouts, and grass seed applied so vehicles can still navigate.
- If a stream crossing will still be needed afterward, then seed/straw, gravel, dips and turnouts may be appropriate to allow vehicle access to continue. If the crossing will not be needed, then consider removing it entirely.
- If trespassing is a concern, brush can be piled to stabilize soil and also restrict access.
- If a fireline will be used again for future burning, consider recontouring (flattening) the line by disking it, so that it can be easily freshened-up next time with minimal soil disturbance.
- Re-vegetating exposed soil with a diversity of seed mixes can accomplish goals for stabilizing the soil, supporting pollinators, improving aesthetics, and providing a wildlife food source.

Consider the following steps when undertaking site rehab:

1. Control runoff and capture sediment. (…*slow it down and spread it out*…)
2. Stabilize waterway crossings.
3. Prepare soil for revegetation.
4. Seed to revegetate.
5. Mulch.
6. Monitor and repair.

Figure 10B: Stabilized skid trail in the mountains

BMPs for Site Rehab

- On timber harvests: Deposit, crush, and pack down leftover slash (limbs, tops) on critical bare soil areas to provide groundcover during and after the logging operation.
  -- Areas that may need attention include the approachways to skid trail waterway crossings; on sloping or erodible sections of skid trails or temporary roads; and on log decks.
  -- The application of slash is not suitable on permanent roads or on firebreaks.
- Install effective diversion and catchment structures where needed across the job site to control runoff and capture sediment.
  -- Areas that may need attention include log decks, truck staging areas, and upon sloping sections of skid trails, roads or firelines.
- If needed, disk/till compacted soil to create a suitable seedbed for re-vegetation groundcover, and to promote infiltration of rainfall runoff.
- If needed, incorporate appropriate soil amendments such as fertilizer, lime or organic matter.
  -- Consider having a soil analysis done to determine if amendments are recommended.
- Apply groundcover seed on critical bare soil that requires prompt re-vegetation.
  -- Consult Table 10-1 or other suitable recommended seeding options.
  -- Avoid using noxious plants that could become invasive.
- After broadcasting seed, apply mulch (such as straw) to retain moisture and shield the seed from wildlife browsing. Straw should cover at least 75% of the seeded area, but not completely smother the seed.
- Instead of grass seed, a thick layer of wood chips, bark, or mulch may be suitable to provide groundcover. If applied, material should cover nearly 100% of the exposed soil, at a depth of least 4 to 6 inches thick. This treatment is best on flat ground and away from waterways, so the mulch will not wash downslope or float-away during flooding.
- Waterway Crossings: Remove temporary crossings promptly when no longer needed.
- Waterway Crossings: Stabilize bare soil on the channel banks.
- Waterway Crossings: Remove excessive debris and soil introduced during the forestry operation, to prevent obstructing waterway flow.
- Waterway Crossings: Re-contour the channel bank and approachways as needed to stabilize them. Do not make the channel wider or deeper than it was originally.
- Consider working with the landowner to control access onto the rehabilitated site so groundcover vegetation can become established. Examples of control measures include gates, fences, brush piles, trenches or tall waterbars/berms.
- Monitor and make repairs until the forestry-related work is permanently stabilized effectively to restrain accelerated erosion and prevent visible sedimentation into intermittent streams, perennial streams, and perennial waterbodies. Monitoring the site after a heavy rainstorm is usually helpful.

Figure 10C: Same stream crossing before and after rehab

***Picture note**: Logging debris was removed from the stream. More slash was applied to the slope. Grass and straw were applied for groundcover*.

Figure 10D: Primary skid trail stabilized with abundant logging slash

Table 10-1: Seeding Options for North Carolina Forestry Operations

Spring Application Mix	Seeding Rate
Creeping Red Fescue	20 pounds / acre
Red Clover	10 pounds / acre
Oats	1 to 2 bags / acre
Summer Application (Temporary Cover)	**Seeding Rate**
German Foxtail or Browntop Millet	25 pounds / acre
Early Fall Application Mix	**Seeding Rate**
Creeping Red Fescue	20 pounds / acre
Red Clover	10 pounds / acre
Wheat	1 to 2 bags / acre
Late Fall Application Mix	**Seeding Rate**
Creeping Red Fescue	20 pounds / acre
Annual Ryegrass	10 pounds / acre
Rye	1 to 2 bags / acre
Winter Application (Temporary Cover)	**Seeding Rate**
Annual Ryegrass	20 pounds / acre

<<< Helpful Hint #1 >>> These seeding recommendations have been field-tested and were selected because they are relatively low-cost, readily-available, easy to apply, widely adaptable for many soil conditions, and provide erosion control while still allowing native vegetation to re-establish.

<<< Helpful Hint #2 >>> Grains are usually sold by weight (in pounds) or by volume (in bushels):

- Wheat may come in a 50-pound bag, or a 1-bushel sack weighing about 60 pounds.
- Rye may come in a 1-bushel sack weighing about 55 pounds.
- 'Certified' seed oats may come in a 2-bushel sack weighing about 65 pounds.
- Whole feed oats may come in a 50-pound bag. These are lower cost than Certified oats and can be used with the Spring Application Mix.
- Oats are not as cold-tolerant as wheat or rye, and therefore may die in the winter.
- When seeding with grains, 1 bag or sack (from 50 to 60 pounds total) should be adequate on most sites. If there is steep slope or loose soil, consider applying 2 bags or sacks of seed.

<<< Helpful Hint #3 >>> If a soil analysis is not done, below are generic soil amendment recommendations that may benefit groundcover establishment during all seasons of application:

- Fertilizer: 400 pounds per acre of 10-10-10.
- Lime: 2,000 pounds per acre of ground agricultural lime.

Conversions to obtain the pounds of fertilizer that provides 1 pound (#) of nitrogen per 1,000 sq. feet:

20# of 5-5-5	20# of 5-10-5	20# of 5-10-10
10# of 10-10-10	12.5# of 8-8-8	6.25# of 16-0-0

Appendix 1: Agency Contact Information

This list includes phone numbers for the N.C. Forest Service county ranger offices and the phone number for each county office of the USDA-Natural Resources Conservation Service (NRCS), which commonly shares offices with the county's Soil & Water Conservation District (S&WCD). For the most current forestry office phone numbers, please reference the "Contact Us" section of our website: *www.ncforestservice.gov*

County	N.C. Forest Service	USDA-NRCS and County S&WCD
Alamance	336-376-3596	336-228-1753x3
Alexander	828-632-5810	828-632-2708
Alleghany	336-372-8142	336-372-4645x240
Anson	704-848-4705	704-694-3516x3
Ashe	336-846-2471	336-246-5461x3
Avery	828-766-8043	828-733-2291
Beaufort	252-946-3944	252-946-4989x3
Bertie	252-794-3725	252-509-3065
Bladen	910-588-4861	910-862-3179x3
Brunswick	910-755-7772	910-253-4448x3
Buncombe	828-686-5885	828-254-0916x3
Burke	828-438-6269	828-439-9727x3
Cabarrus	980-335-0009	704-788-2107x3
Caldwell	828-757-5612	828-758-1111
Camden	252-336-4332	252-338-1919x262
Carteret	252-728-3793	252-222-6360
Caswell	336-694-6131	336-694-4581x3
Catawba	828-465-8443	828-464-1382x3
Chatham	919-542-5739	919-542-2244x3
Cherokee	828-837-5426	828-837-6417x3
Chowan	252-482-4554	252-482-4127x3
Clay	828-389-4190	828-389-8852
Cleveland	704-487-4954	704-471-0235x3
Columbus	910-654-4739	910-642-2196x3
Craven	252-244-0295	252-637-2547
Cumberland	910-483-1535	919-484-8479x3
Currituck	252-232-0983	252-232-3360
Dare	252-473-2531	252-475-5853
Davidson	336-859-9171	336-248-2687x3
Davie	336-751-5319	336-751-5011
Duplin	910-289-2735	910-296-2121x3
Durham	919-560-0562	919-560-0558
Edgecombe	252-823-8346	252-823-8187x3
Forsyth	336-767-7269	336-767-0720x3
Franklin	919-496-3665	919-496-3137x3
Gaston	704-922-0719	704-922-3806x3
Gates	252-357-0123	252-357-0290x3

County	N.C. Forest Service	USDA-NRCS and County S&WCD
Graham	828-479-6341	828-479-9268
Granville	919-693-3154	919-693-4603x3
Greene	252-747-3879	252-747-2968x3
Guilford	336-641-2406	336-375-5401x3
Halifax	252-826-3219	252-583-3481x3
Harnett	910-893-4391	910-893-5101x3
Haywood	828-627-6551	828-452-2741x3
Henderson	828-891-3957	828-697-4949x3
Hertford	252-358-3761	252-358-7846
Hoke	910-875-2808	910-875-8685x3
Hyde	252-926-9201	252-926-4195
Iredell	704-878-4216	704-873-6761x3
Jackson	828-631-9316	828-586-6344
Johnston	919-989-1925	919-934-7156x3
Jones	252-448-5531	252-448-2731
Lee	919-775-5214	919-775-3407x3
Lenoir	252-520-2400	252-526-9799x3
Lincoln	704-992-0719	704-736-8501
Macon	828-369-8677	828-524-3311x3
Madison	828-649-3821	828-649-2712x3
Martin	252-792-3183	252-508-7136
McDowell	828-652-2636	828-652-4434
Mecklenburg	980-335-0009	704-344-6265
Mitchell	828-688-9405	828-765-4701x3
Montgomery	910-576-5481	910-572-2700
Moore	910-235-0216	910-947-5183x3
Nash	252-459-7338	252-459-4116x3
New Hanover	910-251-5750	910-798-6032
Northampton	252-534-4741	252-534-2591x3
Onslow	910-324-3633	910-455-4472
Orange	919-732-8152	919-245-2750x3
Pamlico	252-745-3775	252-745-4303x3
Pasquotank	252-426-5551	252-338-6353x3
Pender	910-259-7251	910-259-9123x3
Perquimans	252-426-5551	252-426-5545
Person	336-599-5111	336-597-2973x3
Pitt	252-355-9079	252-351-8038x3
Polk	828-894-8020	828-894-8550
Randolph	336-879-1773	336-629-4449x3
Richmond	910-582-7029	910-997-8244x3
Robeson	910-618-5540	910-739-5478x3
Rockingham	336-634-3021	336-342-0460x3
Rowan	704-216-8993	704-637-1604x3

County	N.C. Forest Service	USDA-NRCS and County S&WCD
Rutherford	828-286-9201	828-287-4220x3
Sampson	910-592-4515	910-592-7963x3
Scotland	910-276-0455	910-277-2433
Stanly	704-982-5317	704-982-5114x3
Stokes	336-593-8154	336-593-2490
Surry	336-356-8177	336-386-8751x3
Swain	828-488-1003	828-488-3785x3
Transylvania	828-884-3212	828-884-3230
Tyrrell	252-796-5841	252-796-3701
Union	704-233-1437	704-233-1621x3
Vance	252-438-7249	252-438-5727
Wake	919-841-4046	919-250-1070
Warren	252-257-5960	252-257-3836x3
Washington	252-797-4722	252-791-0108
Watauga	828-265-5375	828-264-3943
Wayne	919-731-2010	919-734-5281x3
Wilkes	336-973-4104	336-838-3622x3
Wilson	252-237-0914	252-237-5147
Yadkin	336-679-8941	336-679-8052x3
Yancey	828-682-6788	828-682-2466

N.C. Department of Environmental Quality Regional Offices
https://deq.nc.gov/about/contact/regional-offices

Asheville Regional Office
828-296-4500
2090 US Highway 70
Swannanoa, NC 28778

Fayetteville Regional Office
910-433-3300
225 Green Street - Suite 714
Fayetteville, NC 28301-5094

Mooresville Regional Office
704-663-1699
610 East Center Avenue
Mooresville, NC 28115

Raleigh Regional Office
919-791-4200
3800 Barrett Drive
Raleigh, NC 27609

Washington Regional Office
252-946-6481
943 Washington Square Mall
Washington, NC 27889

Wilmington Regional Office
910-796-7215
127 Cardinal Drive Extension
Wilmington, NC 28405

Winston-Salem Regional Office
336-776-9800
450 West Hanes Mill Road, Suite 300
Winston-Salem, NC 27105

U.S. Army Corps of Engineers in North Carolina

www.saw.usace.army.mil

Wilmington Regulatory Division and Field Office
69 Darlington Avenue
Wilmington, North Carolina 28403
910-251-4811

Asheville Regulatory Field Office
151 Patton Avenue, Room 208
Asheville, North Carolina 28801
828-271-7980

Raleigh Regulatory Field Office
3331 Heritage Trade Drive - Suite 105
Wake Forest, North Carolina 27587
919-554-4884

Washington Regulatory Field Office
2407 West Fifth Street
Washington, North Carolina 27889
910-251-4610

North Carolina Wildlife Resources Commission

www.ncwildlife.org

Raleigh Central Office: 1751 Varsity Drive Raleigh, NC 27606
Wildlife Management Division & Endangered Species: (919) 707-0050

U.S. Fish & Wildlife Service Ecological Services Field Offices

www.fws.gov

Asheville Field Office Phone: (828) 258-3939
160 Zillicoa Street
Asheville, NC 28801-1082

Raleigh Field Office Phone: (919) 856-4520
551 Pylon Drive - Suite F
Raleigh, NC 27606-1487

Sandhills Area Sub-Office (Southern Pines): Phone: (910) 695-3323
Coastal Area Sub-Office (Manteo): Phone: (252) 473-1131

North Carolina Natural Heritage Program

www.ncnhp.org

Phone: (919) 707-8107 (Director's Office)

Cooperative Extension Forestry Department at N.C. State University

https://forestry.ces.ncsu.edu/

Dr. Bob Bardon, Department Leader: Phone: (919) 515-5575

USDA-Forest Service ("U.S. Forest Service") National Forests in North Carolina

Forest Supervisor - Asheville, NC 828-257-4200 **www.fs.usda.gov/nfsnc**

Pisgah National Forest

Appalachian Ranger District
Mars Hill, NC 828-689-9694

Grandfather Ranger District
Nebo, NC 828-652-2144

Pisgah Ranger District
Pisgah Forest, NC 828-877-3265

Nantahala National Forest

Cheoah Ranger District
Robbinsville, NC 828-479-6431

Nantahala Ranger District
Franklin, NC 828-524-6441

Tusquitee Ranger District
Murphy, NC 828-837-5152

Croatan National Forest

New Bern, NC 252-638-5628

Uwharrie National Forest

Troy, NC 910-576-6391

U.S. Forest Service, Southern Research Station Experimental Forests in N.C.

USFS Southern Research Station Headquarters
Asheville, NC (828) 257-4832

Bent Creek Experimental Forest
Asheville, NC 828-667-5261

Coweeta Hydrologic Laboratory
Otto, NC 828-524-2128

Appendix 2: Conversion Factors and Calculations used in Forestry

Distance Factors

1 mile = 5,280 feet	½ mile = 2,640 feet	¼ mile = 1,320 feet	1/10 mile = 528 feet
1 mile = 1,760 yards	½ mile = 880 yards	¼ mile = 440 yards	1/10 mile = 176 yards
1 mile = 80 chains	½ mile = 40 chains	¼ mile = 20 chains	1/10 mile = 8 chains

NOTE: 1 chain = 66 feet; 1 yard = 3 feet

Area Factors

1 acre = 43,560 square feet
1 square mile = 640 acres
NOTE: A football field is approximately 1.3 acres in area

To Determine Acres of an Area: Step 1: Multiply the LENGTH feet (x) WIDTH feet.
Step 2: Take this answer and divide it by 43,560.

For Example: *A log deck is 85 feet wide and 170 feet long. (85 x 170 = 14450)*
14450 ÷ 43560 = 0.33 acre in size.

Acres Table for Road, Trail or Deck Size

Length in Feet	Width in Feet							
	10	12	15	20	35	50	75	100
25	0.006	0.007	0.009	0.011	0.02	0.03	0.04	0.06
50	0.011	0.014	0.02	0.02	0.04	0.06	0.09	0.11
75	0.02	0.02	0.03	0.03	0.06	0.09	0.13	0.17
100	0.02	0.03	0.03	0.05	0.08	0.11	0.17	0.23
125	0.03	0.03	0.04	0.06	0.10	0.14	0.22	0.29
150	0.03	0.04	0.05	0.07	0.12	0.17	0.26	0.34
175	0.04	0.05	0.06	0.08	0.14	0.20	0.30	0.40
200	0.05	0.06	0.07	0.09	0.16	0.23	0.34	0.46
250	0.06	0.07	0.09	0.11	0.20	0.29	0.43	0.57
500	0.11	0.14	0.17	0.23	0.40	0.57	0.86	1.15
750	0.17	0.21	0.26	0.34	0.60	0.86	1.29	1.72
1000	0.23	0.28	0.34	0.46	0.80	1.15	1.72	2.30
1250	0.29	0.34	0.43	0.57	1.00	1.43	2.15	2.87
1500	0.34	0.41	0.52	0.69	1.21	1.72	2.58	3.44
1750	0.40	0.48	0.60	0.80	1.41	2.01	3.01	4.02
2000	0.46	0.55	0.69	0.92	1.61	2.30	3.44	4.59
2500	0.57	0.69	0.86	1.15	2.01	2.87	4.30	5.74
5000	1.15	1.38	1.72	2.30	4.02	5.74	8.61	11.48
5280	1.21	1.45	1.82	2.42	4.24	6.06	9.09	12.12

Calculating Percent (%) Slope of Existing Land Surface

To determine the **percent slope of existing** roads, trails or the land surface:
Measure the vertical elevation and divide by the horizontal distance. For example:

- A skid trail has an 8-foot change in elevation over a horizontal distance of 55 feet.
- Therefore, 8 ft ÷ 55 ft = 0.145. Multiply your answer x100. The % slope for this example is 14.5%.

Percent (%) Slope of Existing Surfaces

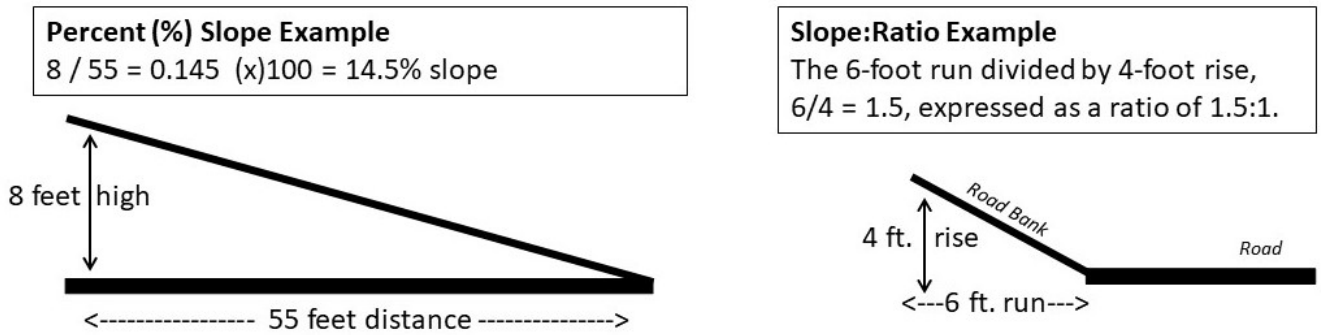
Vert.	Horizontal Distance										
Elev.	10	15	20	25	33	50	66	75	100	150	200
1	10%	7%	5%	4%	3%	2%	2%	1%	1%	1%	1%
2	20%	13%	10%	8%	6%	4%	3%	3%	2%	1%	1%
3	30%	20%	15%	12%	9%	6%	5%	4%	3%	2%	2%
4	40%	27%	20%	16%	12%	8%	6%	5%	4%	3%	2%
5	50%	33%	25%	20%	15%	10%	8%	7%	5%	3%	3%
6	60%	40%	30%	24%	18%	12%	9%	8%	6%	4%	3%
7	70%	47%	35%	28%	21%	14%	11%	9%	7%	5%	4%
8	80%	53%	40%	32%	24%	16%	12%	11%	8%	5%	4%
9	90%	60%	45%	36%	27%	18%	14%	12%	9%	6%	5%
10	100%	67%	50%	40%	30%	20%	15%	13%	10%	7%	5%
12	-	80%	60%	48%	36%	24%	18%	16%	12%	8%	6%
14	-	93%	70%	56%	42%	28%	21%	19%	14%	9%	7%
16	-	107%	80%	64%	48%	32%	24%	21%	16%	11%	8%
18	-	-	90%	72%	55%	36%	27%	24%	18%	12%	9%
20	-	-	100%	80%	61%	40%	30%	27%	20%	13%	10%

Calculating *Slope:Ratio* for Grading & Construction

Slope ratio for grading and construction is measured as the horizontal 'run' over its vertical 'rise'.
This is ***opposite*** of the more common practice to measure the "% slope" as shown in the above table.

- Slope ratio is expressed mathematically in a way so that the second digit (the 'rise') is 1.
- In other words, a 2:1 slope ratio has a 2 feet 'run' distance-factor for every 1 foot of 'rise' height.
- A 2:1 slope [horizontal run is only 2x the rise height] is steeper than a 4:1 slope [run is 4x the rise].
- Therefore, steeper slopes have a smaller first digit in the ratio than flatter slopes.

As a forestry example:
A road's side / cut bank is graded across a horizontal 'run' distance of 6 feet, with a vertical 'rise' height of 4 feet. This side / cut bank therefore has a slope of 6/4, expressed as a ratio **1.5:1** (from 6 ÷ 4).



Appendix 3: Web Resources for Mapping and Planning

N.C. Forest Service, Forestry Preharvest Planning & Mapping Tool
https://www.ncforestservice.gov/water_quality/fppt.htm

USGS Topographic Maps
TopoView: https://ngmdb.usgs.gov/topoview/viewer/#4/40.00/-100.00
The National Map: https://www.usgs.gov/programs/national-geospatial-program/national-map

USDA-NRCS Soil Surveys, Printed Manuscript Maps
https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=NC

USDA-NRCS Web Soil Survey: https://websoilsurvey.nrcs.usda.gov
{ NOTE: cannot use for Riparian Buffer Rules; must look at printed manuscript map }

Rainfall Monitoring from National Weather Service
https://www.weather.gov/akq/rainfall-monitoring

Streamflow and Hydrologic Data from USGS
https://dashboard.waterdata.usgs.gov/app/nwd/?aoi=default

Soil Moisture Estimates
NASA: https://weather.msfc.nasa.gov/sport/case_studies/lis_NC.html
USDA: https://nassgeo.csiss.gmu.edu/CropCASMA/

U.S. Fish and Wildlife Service, T&E Species Critical Habitat Online Mapper
https://ecos.fws.gov/ecp/report/table/critical-habitat.html

N.C. Div. of Water Resources Map Locator
https://experience.arcgis.com/experience/689283d17bf342c2a96364fbab09a5d8

N.C. OneMap: https://www.nconemap.gov/

N.C. Surface Water Classifications
https://ncdenr.maps.arcgis.com/apps/webappviewer/index.html?id=6e125ad7628f494694e259c80dd64265

National Radar Alternative: Multi-Radar Multi-Sensor Operational Product Viewer
https://mrms.nssl.noaa.gov/qvs/product_viewer/

N.C. Flood Plain Maps: https://flood.nc.gov/ncflood/

N.C. Natural Heritage Program:
Conservation Planning Tool:
https://www.ncnhp.org/conservation/north-carolina-conservation-planning-tool

Natural Heritage Elements, Dedicated Nature Preserves, etc.:
https://www.ncnhp.org/conservation-and-classification-north-carolinas-natural-heritage

Appendix 4: Logging Systems Descriptions

The proper selection of a logging system involves consideration of many different conditions:

- Slope and terrain
- Type of water resources/wet areas present
- Skidding or yarding distance
- Weather
- Soils
- Tree size and volume per acre
- Size of tract
- Cost of road construction
- Cost of logging
- Productivity goals

Below is a basic description (listed alphabetically) of the most common logging systems found in the southeastern United States. Potential water quality issues are provided in bulleted text for each system.

Animal

Large working animals (horses, mules, oxen, etc.) pull individual logs along the ground or carts that carry logs partially suspended off the ground.

- ✓ When done correctly on a limited basis it can minimize the severity and intensity of soil disturbance.
- × It may require more roads, due to limited skidding distances for animals. This increased amount of roads can lead to increased potential for soil runoff.
- × Care must be taken to minimize "gouging" of the soil by animal hooves and/or the skidded logs.

Cable Yarding

This system uses a combination of a winch, cables and a carriage to collect logs by suspending them off the ground with a thick wire cable rope. A carriage is the device that moves in and out from the yarder to the timber and contains the cable ends used to attach onto the logs.

- ✓ Ground disturbance is minimized, and the need for skid trails is reduced or eliminated altogether.
- ✓ The need for forest roads is reduced, and those forest roads that are needed may be located further from bodies of water than what may be possible with other systems.
- × Due to the inherent high costs of operations, this logging system is usually only economical for extremely valuable high-quality timber.

Forwarders

These machines are rubber-tired tractors equipped with a self-contained log loader and a log bunk that can transport logs completely off the ground. Forwarders can reduce the number of forest roads needed since logs can be carried for longer distances from the woods to the deck.

- ✓ High-standard forest road construction is minimized.
- × However, if operations are conducted under wet conditions, soil compaction and site productivity degradation can occur. The use of wider tires and/or add-on metal cleats can help minimize this potential problem.

Helicopter

Helicopters can completely lift cut timber from the woods and fly it to the deck.

- ✓ Ground disturbance is minimized, and the need for skid trails is reduced or eliminated altogether.
- ✓ The need for forest roads is reduced, and those forest roads that are needed may be located further from bodies of water than what may be possible with other systems.
- × Due to the inherent high costs of operations, this logging system is usually only economical for extremely valuable high-quality timber.

Skidder

A skidder is a tractor that uses a cable, grapple, or both, to secure and drag the partially suspended logs/trees to a deck. Skidders may be mounted on tracks or tires.

- ✓ Skidders are the most common logging system in North Carolina and their use is appropriate for most of the site conditions found in the state.
- ✓ Skidders that are mounted on tracks, extra-wide tires, or dual tires can further minimize intensive soil disturbance in some cases and allow operations to continue during adverse conditions.
- × When not used properly, skidders can severely impact water quality and lead to conditions that may degrade long-term site productivity.

Shovel Logging (Loading)

This is a term used to describe a log/tree loader that is mounted on self-propelled tracks. These machines can construct a homemade 'shovel' or 'mat' skid trail made up of logs that other equipment then travels upon, instead of the ground. This shovel trail is then removed as skidding is completed. Shovel logging systems are usually limited to total harvests due to the need to use tree/log material for the mat trail.

- ✓ Shovel systems are able to work effectively in wetter areas than a skidder system because they move timber with the reach and swing of the shovel-arm rather than the traffic movement of a wheeled or tracked machine.
- ✓ Shovel systems allow logging on extremely wet-natured sites while minimizing site disturbance.
- × Due to the ability of this equipment to operate in saturated soil conditions, care must be exercised to ensure sufficient SMZs are established, marked and maintained.

Swing Systems

Swing systems use a combination of all these systems to best utilize each component. For example, a track-mounted felling machine harvests the timber; a shovel-loader moves the trees across a wet area using a 'shovel trail' to reach high ground. From there, a rubber-tired skidder moves the logs across dry ground to the deck.

- ✓ Water quality and site productivity are usually well protected since each machine is being used for its intended purpose.

Track-Mounted Equipment

These are machines mounted on rubber or metal tracks instead of rubber tires. Track-mounted machines are available for tree cutting, skidding, processing, loading or roadwork.

- ✓ When compared to rubber-tired equipment, track machines protect soil better due to the increased "footprint" area of the tracks. This decreases the ground pressure of the unit. Tracked machines minimize soil compaction, especially on wet soil conditions.
- × Due to the ability of this equipment to operate in saturated soil conditions, care must be exercised to ensure sufficient SMZs are established, marked and maintained.

Whole-Tree Chipping

Whole-tree chipping uses large machines that break apart trees into small chip-sized material. These chips are then placed into a chip van trailer that is transported by a truck. The chipped material is used either for making pulp, paper or fuel. This system is typically used on sites that have an abundance of low-quality timber.

- ✓ Chips can serve as a very effective soil cushion on decks and skid trails to minimize and sometimes prevent soil disturbance from occurring.
- ✓ Harvested sites often have high tree utilization, leaving the site more open for reforestation afterwards.
- × Chipping often reduces leftover woody material on the site that could otherwise be used for stabilizing skid trails, stream crossing approachways or decks.
- × Forest access roads often need to be wider, flatter and have broader turns than traditional logging roads, so stability is provided for the high center-of-gravity chip van trailers. Additional BMP work may be needed.

Appendix 5: Table for Round Culvert Sizing

Talbot's Formula

Talbot's formula calculation for a 2.5-inches per hour rainfall (units are square feet).

Area in square feet required for waterway

No. of acres	Impervious 100% runoff	Steep slopes, heavy soils, moderate cover		Moderate slopes, heavy to light soils, dense cover		Gentle slopes, agricultural soils and cover		Flatland pervious soils
	C = 1.00	C = .80	C = .70	C = .60	C = .50	C = .40	C = .30	C = .20
2	1.0	0.8	0.7	0.6				
4	1.7	1.4	1.2	1.0				
6	2.3	1.9	1.6	1.4	1.2	0.9	0.6	
8	2.9	2.3	2.0	1.7	1.4	1.2	0.9	0.6
10	3.4	2.7	2.4	2.0	1.7	1.4	1.0	0.7
20	5.8	4.6	4.0	3.5	2.9	2.3	1.7	1.2
30	8.0	6.3	5.4	4.8	4.0	3.2	2.4	1.6
40	9.8	7.8	6.8	5.9	4.9	3.9	3.0	2.0
50	11.6	9.3	8.0	7.0	5.8	4.6	3.5	2.3
60	13.4*	10.7	9.2	8.0	6.7	5.3	4.0	2.7
70	15.0	12.0	10.3	9.0	7.5	6.0	4.5	3.0
80	16.6	13.3	11.5	10.0	8.3	6.6	5.0	3.3
90	18.2	14.6	12.5	11.0	9.1	7.2	5.4	3.6
100	19.7	15.8	13.5	11.8	9.8	7.8	5.8	3.9
150	26.9	21.2	18.5	16.0	13.3	10.7	8.0	5.4
200	33.2	26.8	22.9	20.0	16.7	13.3	10.0	6.6
250	39.5	31.5	27.1	23.8	19.7	15.7	11.8	7.9
300	45.7	36.1	31.0	27.1	27.0	18.0	13.5	9.0
350	51.0	40.6	35.0	30.5	25.3	20.2	15.0	10.1
400	56.0	45.0	39.0	33.9	28.0	22.2	16.7	11.2
450	61.7	49.7	42.0	37.0	30.6	24.2	18.0	12.3
500	66.8	52.8	46.0	40.0	33.2	26.5	19.8	13.2
600	77.0	61.6	52.5	46.0	38.2	30.3	22.8	15.3
700	86.0	68.4	59.5	52.0	43.0	34.0	25.8	17.2
800	96.0	76.1	65.8	57.0	47.5	38.0	28.5	19.0
900	104.0	83.0	71.7	62.2	51.9	41.5	31.1	20.8
1000	113.0	90.0	77.7	68.0	56.5	45.0	33.7	22.4

*Culverts larger than 48 inches in diameter are discouraged. Where watersheds require culverts larger than 48 inches, bridges, fords or multiple culverts may provide a more suitable crossing solution.

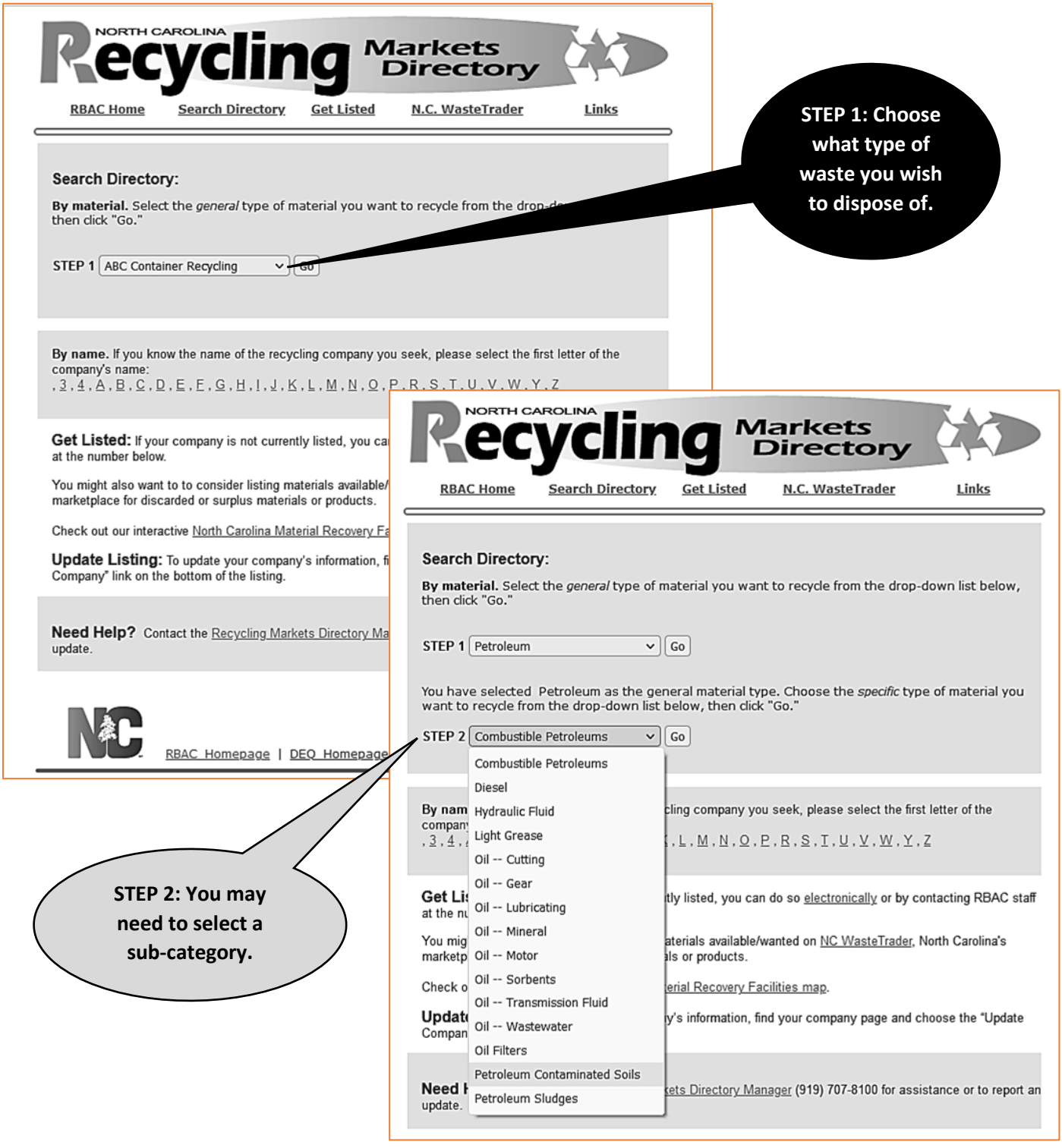
Sizes of round pipe needed for areas of waterway listed in drainage table

Area *(square feet)*	Diameter *(inches)*
1.25	15
1.80	18
3.10	24
4.90	30
7.10	36
9.60	42
12.60	48

The NCFS has an online Excel spreadsheet calculator, where you can adjust Talbot's formula to your your site and scenario: https://www.ncforestservice.gov/water_quality/wq_CulvertSizing.htm.

Appendix 6: Waste Product Recycling Centers

The N.C. Dept. of Environmental Quality (DEQ) and the North Carolina Recycling Business Assistance Center maintain a list of private commercial vendors in North Carolina that accept many different waste materials for recycling including tires, batteries, petroleum and scrap lumber. This information is available at **www.p2pays.org/dmrm/start.aspx**.



STEP 3: You get a list of vendors, like the example shown below for "Petroleum Contaminated Soils."

NORTH CAROLINA Recycling Markets Directory

RBAC Home | Search Directory | Get Listed | N.C. WasteTrader | Links

The following companies accept "Petroleum Contaminated Soils" from N.C.:

Company Name	City	County	State	Phone Number
Aqua Clean Environmental of Virginia LLC Reco Bio-Technology	Richmond		VA	(804) 644-2800
Crandall Corporation	Lexington		SC	(800) 248-4801
E. S. & J. Enterprises	Autryville	Sampson	NC	(910) 567-6138
ECOFLO, Inc.	Greensboro	Guilford	NC	(336) 617-2733
EP&S of VT. Inc. (Carolinas Div.)	Raleigh	Wake	NC	(919) 852-3595
HAZ Mat Environmental Services	Charlotte	Mecklenburg	NC	(704) 332-5600
Heritage Environmental Services, Inc.	Charlotte	Mecklenburg	NC	(828) 707-2470
Heritage-Crystal Clean, Inc.	Concord	Cabarrus	NC	(704) 376-9636
Heritage-Crystal Clean, Inc.	Raleigh	Wake	NC	(919) 771-2892
HERR, Inc.	Whiteville	COLUMBUS	NC	(910) 653-6399
Necessary Oil Company	Bristol		TN	(423) 764-4533
Noble Oil Services, Inc.	Sanford	Lee	NC	(919) 774-8180
Saf-Way Recycler	Conway		SC	(800) 827-7083
Safety-Kleen	Charlotte	Mecklenburg	NC	(704) 375-0098
Safety-Kleen	Archdale	Randolph	NC	(336) 861-4149
Safety-Kleen	Raleigh	Wake	NC	(919) 772-6622
Safety-Kleen Systems	St. Pauls	Robeson	NC	(910) 865-5081
Southern Logistics & Environmental LLC.	Greensboro	Guilford	NC	(336) 662-0292
VLS Recovery Services, LLC	Mauldin		SC	(864) 692-9953

View Printable List - Search Again

The Recycling Markets Directory was last updated on:
11/30/2021 11:51:48 AM

N.C. Recycling Business Assistance Center website:
https://deq.nc.gov/conservation/recycling/programs-offered/recycling-business-assistance-center

Appendix 7: Common Types of Forested Wetlands

Forestry operations and applicable BMPs may differ among wetland types, so a wetland classification system is outlined below. The classification system shown here is based on the hydrogeomorphic (HGM) classification system developed by the USACE (Brinson, 1993; Smith et.al., 1995). There are seven common wetland types described nationally, based on geomorphic setting and hydrologic character. The seven types are briefly described below (listed alphabetically) to provide the reader with a framework for understanding BMPs that may be appropriate to one or more wetland types.

Common names applied to wetlands vary widely and are not standardized enough to use as the basis of a classification system. However, the common names often used by foresters and ecologists are also provided for reference.

Past hydrologic alterations such as large reservoirs that altered flooding regimes in river bottomlands, stream channelization that limited flooding on small streams, and land drainage that altered water table regimes may have caused wetland areas to become wetter or drier. In such situations, the soil condition may be different than described in the county soil survey. On-site assessment of wetland condition should consider the effects of such hydrologic alterations.

Depressional Wetlands
Description: Occur in topographic depressions with a closed elevation contour that allows accumulation of surface water. Usually do not have channel inlets and outlets and commonly occur as inclusions in nonwetland forests.
Hydrology: Influenced by groundwater discharge and interflow from the adjacent uplands, and often, restrictive soil layers that limit seepage downward.
Size: Relatively small (from 0.01 to a few acres), other than Carolina Bays. Carolina Bays range in size from a few acres to several thousand acres. Many have stream outlets and may have mineral or organic soils or complexes of both.
Soils: Soils are usually mineral
Common Name Subtypes: Coastal Plain depressions (Coastal Plain ponds, Coastal Plain sinkholes), maritime depressions (on Outer Banks), perched wetlands (ephemeral wetlands, or vernal pools - small depressional wetlands that occur in forested areas throughout the Piedmont and Mountains).

Lacustrine Fringe Wetlands
Description: Adjacent to lakes where the water elevation of the lake maintains the water table in the wetland.
Hydrology: Influenced by groundwater discharge and interflow from the adjacent uplands, and occasionally, subsurface flow from the lake back into the shoreline soil. During wet periods, the groundwater hydraulic gradient is from land to lake and water flows through the wetland soil are from land to lake. During periods of high evapotranspiration rates, the water table in the wetland may often decline below the lake water level and water flow through the wetland soil is from lake to land.
Size: Dependent upon size of lake
Soils: Soils may be mineral or organic.
Common Name Subtypes: Lacustrine fringe wetlands occur on the shorelines of ponds, lakes and reservoirs throughout the state with vegetation types ranging from open herbaceous marsh to mixed hardwoods or cypress.

Mineral Flat Wetlands
Description: Very low relief, usually relatively large areas in the Coastal Plain that occur on flat interstream uplands or large flood plain terraces
Hydrology: Influenced by low relief and slowly permeable soil layers that limit rates of runoff and downward seepage. Precipitation is the only source of water for mineral flat wetlands that occur on high terrain areas. Subsurface groundwater input influences hydrology where adjacent uplands are at higher elevation than the wetland.
Size: From tens up to hundreds or thousands of acres
Soils: Mineral soils only. As a result, the texture of the soil surface layers may range from sandy texture with very low organic carbon content to shallow organic layers (histic epipedon) up to 15” thick.
Common Name Subtypes: Wet pine flats-mineral (including drained and undrained pine plantations), wet hardwood flats, non-riverine swamp forest (mineral soils), wet pine savanna, mixed pine-hardwood flats

Organic Flat Wetlands

Description: Very low relief, usually relatively large areas in the Coastal Plain that are similar in geomorphic locations and hydrologic character to mineral flat wetlands except that wetter conditions have resulted in the development of organic soils.

Hydrology: Direction of runoff is horizontally outward in all directions in large domed peatlands but may flow across in some organic soil flats.

Size: From tens up to hundreds or thousands of acres

Soils: Soils have a surface or near surface layer of organic soil material that is 16" or thicker

Common Name Subtypes: Pocosins, wet pine flats-organic (including drained and undrained pine plantations), white cedar forest, nonriverine swamp forest (organic soils)

Riverine Wetlands

Description: Occur in riparian zones and flood plains along stream channels throughout the state

Hydrology: Influenced by groundwater discharge and inter-flow from the adjacent uplands and overbank flow from the stream in areas that sustain frequent, long duration flooding

Size: Range in size from small inclusions (down to 0.01 ac.) in nonwetland riparian zones in the Piedmont and Mountains to extensive floodplain swamps in the Coastal Plain (up to hundreds or thousands of acres).

Soils: Both mineral and organic hydric soils occur. Note that many bottomland hardwood forests occur on somewhat poorly drained soils to well-drained soils that are nonhydric, but it is recommended that all BMPs described in this chapter be utilized for forestry operations on flood plains.

Common Name Sub-types: Wet headwaters forests, wet bottomland hardwoods, mountain bogs and bog forests, blackriver bottom forest, muck swamps, gum-cypress swamps

Slope Wetlands

Description: Normally found on sloping terrain where there is a discharge of groundwater to the land surface, usually due to a restrictive layer in the soil

Hydrology: The surface runoff of water from large slope wetlands often forms channels that are the origins of first order streams and the slope wetland may transition to riverine wetlands along the stream.

Size: Slope wetlands or seeps are usually small, much less than an acre, but may range up to several acres in size.

Soils: Soils are usually mineral

Common Name Subtypes: Usually occur as small inclusions in nonwetland forested areas throughout the upper Coastal Plain, Piedmont and Mountains

Tidal Fringe Wetlands

Description: Occur along sea coasts and sound or estuary shorelines and are under the influence of sea level and regular lunar tide cycles.

Hydrology: Intergrade with riverine wetlands in estuaries where tidal currents diminish and river flow is constantly downstream. In NC, the tidal fringe wetlands along the sound shorelines are also influenced by irregular wind tides.

Size: Subject to bi-directional subsurface and surface flow, the pattern of which is controlled by the tidal pattern.

Soils: Soils may be mineral or organic.

Common Name Subtypes: Tidal hardwoods, tidal gum-cypress swamp, and tidal marshes of various types, depending on water salinity. Coastal Wetlands as defined in NC G.S.113-229(n)(3) are a subset of tidal marshes that contain one or more of 10 marsh grass species.

December 2020 *WQ-10*

A Guide to the Forest Harvest Requirements of the Consolidated Riparian Buffer Rules for:

Catawba River & Mainstem Lakes,
Randleman Lake Watershed,
Neuse River Basin, and
Tar-Pamlico River Basin.

On June 15, 2020 revised Forest Harvest Requirements for these four Buffer Rules became effective. The new consolidated rule is 15A NCAC 02B .0612. This Leaflet does not provide legal advice or final interpretation of these Buffer Rules. Contact the appropriate Regional Office of the NCDEQ-Div. of Water Resources (NC-DWR) for guidance.

>>> There are different/separate Buffer Rules for the Goose Creek Watershed and Jordan Lake Watershed. <<<

The North Carolina Forest Service (NCFS) can assist by determining which streams/waterways require each Buffer Rule. Contact the appropriate NCFS District Office or Water Quality Forester to request this free service.

1. Where the Consolidated Buffer Rule Applies

- ✓ Along the margins of the **Catawba River** and its mainstem lakes; starting at Lake James, continuing southward to the NC/SC state line.
- ✓ Along designated or mapped 'blueline' streams and bodies of water (see pg.2, section 2) in the **Randleman Lake watershed**, and the **Neuse River basin**, and the **Tar-Pamlico River basin**.

NOTE: In Randleman Lake Watershed, this Buffer Rule is also required on un-mapped streams that are Intermittent or Perennial; and required along ditches that outlet into an Intermittent or Perennial stream.

Exemptions

The Buffer Rule does not apply to the following features in these 4 river basins or watersheds:

- × Any ephemeral stream (sometimes called a slough, swale, gully, draw, hollow, or drain).
- × Man-made ditch or canal that is not intended for water navigation or boat access [*except in Randleman Lake watershed, see NOTE above*].
- × Man-made pond or lake that is located outside of a natural drainageway.
- × Agricultural/Farm pond.

Contact the NC-DWR for clarifications of these exemptions.

Beaver Impoundments

Beaver ponds are not exempted. On beaver impoundments (beaver ponds, beaver swamps, etc.), the Buffer Rule Zone must begin at the water's edge, even if there is standing timber out in the beaver swamp. If you wish to breach the beaver dam, let the water drain off, and wait for the stream to re-establish its natural course; then you can start the Buffer Rule Zone along the re-established stream channel. If machinery is needed to breach the dam, then a permit may be needed. ***Contact the NC-DWR for guidance before disturbing the beaver dam***.

2. Types of Streams & Waterbodies that Require this Buffer Rule

This Buffer Rule applies to 'blueline' Intermittent streams, 'blueline' Perennial streams, ponds, lakes, and estuaries that are approximately shown on the **most recently published** version of either: (1) a NRCS county **soil survey manuscript**, or (2) a USGS 1:24000 quad [7.5 minute] **topographic map**.

*****Web Soil Survey and ArcGIS map layers are not acceptable.*****

Where to Download Acceptable Maps:

NRCS Soil Maps: https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=NC

The NCFS has a step-by-step guide (linked below) to locate and download PDF scans of soil survey maps: https://www.ncforestservice.gov/water_quality/pdf/soilMaps.pdf

USGS Topo Maps: https://ngmdb.usgs.gov/topoview/viewer/#4/39.98/-100.06

Make sure you download the most recent version of the 1:24000 map.

3. Buffer Rule Zone Widths and Starting Points

The entire Buffer Rule Zone is 50 feet wide, divided into Zone 1 and Zone 2:

Zone 1 is sub-divided: Inner Zone 1 = 0 to 10 foot mark (10 feet wide).
Outer Zone 1 = 10 to 30 foot mark (20 feet wide).
Zone 2 = 30 to 50 foot mark (20 feet wide).

The Buffer Rule Zone is measured horizontally on a line perpendicular to the surface water:

Zone 1 - For streams: Begin at the most landward limit of the top of bank or the rooted herbaceous vegetation, and extend landward a distance of 30 feet on all sides of the stream (include a radius 'bulb' at head of stream).

Zone 1 - For ponds, lakes, reservoirs: Begin at the normal water level and extend landward a distance of 30 feet.

Zone 1 - For the 20 Coastal NC counties: Begin at the most landward limit of the normal high water level or the normal water level, and extend landward a distance of 30 feet.

Zone 2 - For all sites: Zone 2 begins at the outer edge of Zone 1 and extends outward 20 feet and shall consist of a stable, vegetated area. Ground cover must allow water infiltration and diffusion.

Inner Zone 1: 0 to 10ft — *Only Cut High-Value Trees. *Do Not Cut Streambank Trees**

Outer Zone 1: 10 to 30ft — *Cut no more than 50% of Trees Larger than 5" DBH. Remaining Trees Should be Evenly Spaced Apart.*

Zone 2: 30 to 50ft — *All Trees Can be Harvested. Maintain Groundcover.*

Landowner BMP Tip: For maximum protection of water quality and efficient logging, consider having the timber buyer and logger keep all trees un-cut in all of Zone 1 (0 - 30 ft).

4. Harvesting Timber in the Buffer Rule Zone

- ✓ All forest harvesting must comply with the FPGs. The Buffer Rules do not replace the FPGs.
- ✓ Timber felling shall be directed away from the stream or waterbody.
- ✓ Skidding shall be directed away from the stream or waterbody, and shall be done in a manner that minimizes soil disturbance and prevents the creation of channels or ruts.
- x **No log decks or sawmill sites are allowed in the entire 50-foot Buffer Rule Zone.**

Is Your Tract Eligible?

Harvesting in any part of Zone 1: 0 to 30 feet.

Selective timber harvesting is only allowed in Zone 1 of the Buffer Rule if:

- The tract has a forest management plan that was prepared or approved by a Registered Forester; or,
- The parcel is enrolled in that county's Present-Use Value (PUV) tax deferment program for forestry use.

Allowed:	Selective timber harvest that minimizes disturbance to the soil and remaining vegetation.
Allowed with Restrictions:	Tracked or wheeled vehicles are allowed in Zone 1 for harvesting timber where there is no other practical alternative.
Prohibited:	***No tracked or wheeled vehicles for site prep.***

Inner Zone 1: 0 to 10 foot mark

Allowed:	Selective harvesting of only "High Value" trees.
Allowed with Restrictions:	For Pine species, High Value is: DBH is 14" or larger; Or stump diameter is 18" or larger. For non-Pine species, High Value is: DBH is 16" or larger; Or stump diameter is 24" or larger.
Prohibited:	***No cutting of any tree that has exposed primary roots visible in the streambank.***

Outer Zone 1: 10 to 30 foot mark

Allowed:	Selective harvesting of any tree with a DBH larger than 5".
Allowed with Restrictions:	Harvest no more than 50% of the trees that are larger than 5" DBH. Remaining trees must be as evenly spaced apart as possible. Re-entry for natural forest is allowed every 15 years. Re-entry for plantation forest is allowed every 5 years.
Prohibited:	***No cutting of trees smaller than 5" DBH.*** ***No clearcutting allowed in Zone 1.***

Harvesting in Zone 2: 30 to 50 feet.

All timber harvesting and forest regeneration is allowed, so long as ground cover is established and maintained to provide for diffusion and infiltration of surface runoff.

5. Other Forest Management Activities in the Entire 50-foot Buffer Zone

Allowed

- ✓ Individual trees may be treated to maintain or improve their health, form, or vigor.
- ✓ Removal of individual trees that are in danger of causing damage to structure or human life.
- ✓ Natural regeneration of forest vegetation, and planting of trees, shrubs or ground cover; provided that soil disturbance is minimized.

Allowed with Restrictions

- Harvest of dead or infected trees or application of pesticides as necessary to prevent or control the spread of tree pest and disease infestation. Must be approved by the NCFS, and the NCFS must notify the NC-DWR within 60 days.
- Prescribed burns are allowed when conducted for forest management purposes.
- A one-time fertilizer application at agronomic rates to establish replanted vegetation. No runoff from the fertilizer application is allowed into surface water.

CATAWBA, RANDLEMAN, NEUSE & TAR-PAMLICO

North Carolina Forest Service

FORESTRY Leaflets

December 2020 WQ-11

A Guide to the Forest Harvest Requirements of the Riparian Buffer Rule for: *Goose Creek Watershed.*

On June 15, 2020, revised Forest Harvest Requirements for this Buffer Rule became effective. The newly revised rule is 15A NCAC 02B .0608. This Leaflet does not provide legal advice or final interpretation of this Buffer Rule. Contact the Mooresville Regional Office of the NCDEQ-Div. of Water Resources (NC-DWR) for guidance.

The North Carolina Forest Service (NCFS) can assist by determining which streams/waterways require this Buffer Rule. Contact the NCFS Mt. Holly District Office or Water Quality Forester to request this free service.

1. Where This Buffer Rule Applies

- ✓ Along designated mapped streams and bodies of water (see section 2 below) in the entire Goose Creek watershed of Mecklenburg and Union counties of North Carolina.
- ✓ This watershed is part of Mecklenburg and Union counties, and includes Goose Creek, Stevens Creek, Paddle Branch, Duck Creek, and all their tributaries -- see vicinity map Page 4.

Exemptions

The Buffer Rule does not apply to the following features:

- × Any ephemeral stream (sometimes called slough, swale, gully, draw, or drain).
- × Man-made ditch or canal that is not intended for water navigation or boat access.
- × Man-made pond or lake that is located outside of a natural drainageway.
- × Agricultural/Farm pond.

Contact the NC-DWR for clarifications of these exemptions.

Beaver Impoundments

Beaver ponds are not exempted. On beaver impoundments (beaver ponds, beaver swamps, etc.), the Buffer Rule Zone must begin at the water's edge, even if there is standing timber out in the beaver swamp. If you wish to breach the beaver dam, let the water drain off, and wait for the stream to re-establish its natural course; then you can start the Buffer Rule Zone along the re-established stream channel. If machinery is needed to breach the dam, then a permit may be needed. ***Contact the NC-DWR for guidance before disturbing the beaver dam***.

2. Types of Streams & Waterbodies that Require this Buffer Rule

This Buffer Rule applies to 'blueline' Intermittent streams, 'blueline' Perennial streams, ponds, lakes, and estuaries that are approximately shown on the **most recently published** version of either: (1) a NRCS county **soil survey manuscript**, or (2) a USGS 1:24000 quad [7.5 minute] **topographic map**.

*****Web Soil Survey and ArcGIS map layers are not acceptable.*****

Where to Download Acceptable Maps:

NRCS Soil Maps: https://www.nrcs.usda.gov/wps/portal/nrcs/surveylist/soils/survey/state/?stateId=NC

The NCFS has a step-by-step guide (linked below) to locate and download PDF scans of soil survey maps: https://www.ncforestservice.gov/water_quality/pdf/soilMaps.pdf

USGS Topo Maps: https://ngmdb.usgs.gov/topoview/viewer/#4/39.98/-100.06

Make sure you download the most recent version of the 1:24000 map.

3. Buffer Rule Zone Widths and Starting Points

The Goose Creek Buffer Rule has different requirements depending on the stream or waterbody location:

- **If it is within the 100-Year Floodplain, then a 200-foot wide Buffer Rule Zone is required.** *See Example A below*.
- **If it is outside the 100-Year Floodplain, then a 100-foot wide Buffer Rule Zone is required.** *See Example B below*.

The 100-Year Floodplain is delineated by the North Carolina Floodplain Mapping Program: www.ncfloodmaps.com.

Landowner BMP Tip: For maximum protection of water quality and efficient logging, consider having the timber buyer and logger keep all trees un-cut within the 0 to 50-foot mark.

Example A: Located within 100-Year Floodplain, a 200-foot wide Buffer Rule Zone is required.

Zone 1: 0 to 10ft *Only Cut High-Value Trees.* ***Do Not Cut Streambank Trees****

Zone 2: 10 to 50ft *Cut up to 50% of Trees Larger than 5" DBH. Remaining Trees Should be Evenly Spaced Apart.*

Zone 3: 50 to 200ft *All Trees Can be Harvested. Must establish and maintain groundcover to allow infiltration. See page 3, Section 4 for additional requirements. No Mechanical site prep from 0-200ft.*

Example B: Located outside 100-Year Floodplain, only a 100-foot wide Buffer Rule Zone is required.

Zone 1: 0 to 10ft *Only Cut High-Value Trees.* ***Do Not Cut Streambank Trees****

Zone 2: 10 to 50ft *Cut up to 50% of Trees Larger than 5" DBH. Remaining Trees Should be Evenly Spaced Apart.*

Zone 3: 50 to 100ft *All Trees Can be Harvested. Must establish and maintain groundcover to allow infiltration. See page 3, Section 4 for additional requirements. No Mechanical site prep from 0-100ft.*

The Buffer Rule Zone is measured horizontally on a line perpendicular to the surface water:

For streams: Begin at the most landward limit of the top of bank or the rooted herbaceous vegetation and extend landward on all sides of the stream. Include a bulb radius at head of stream.

For ponds, lakes, reservoirs: Begin at the normal water level and extend landward.

4. Harvesting Timber in the Buffer Rule Zone

Is Your Tract Eligible?

Timber harvesting is only allowed in the entire 100-ft or 200-ft Buffer Rule Zone if:

- ✓ The tract has a forest management plan that was prepared or approved by a Registered Forester; or,
- ✓ The parcel is enrolled in that county's Present-Use Value (PUV) tax deferment program for forestry use.

- All forest harvesting must comply with the FPGs. The Buffer Rules do not replace the FPGs.
- Timber felling shall be directed away from the stream or waterbody.
- Trees are removed in a manner that minimizes disturbance to the soil and remaining vegetation.
- Skidding shall be directed away from the stream or waterbody, and shall be done in a manner that minimizes soil disturbance and prevents the creation of channels or ruts.

➢ **Tracked or wheeled vehicles are allowed for harvesting timber where there is no other practical alternative.**

x ***No log decks or sawmill sites are allowed in the entire 100-foot or 200-foot Buffer Rule Zone.***
x ***No tracked or wheeled vehicles are allowed for site prep in the entire 100-ft or 200-ft Buffer Rule Zone.***

Extra Requirements to Harvest in Zone 1 (0 to 10 feet)

- Only "High Value" trees are allowed to be cut:
  For Pine species, High Value is: DBH is 14" or larger; Or stump diameter is 18" or larger.
  For non-Pine species, High Value is: DBH is 16" or larger; Or stump diameter is 24" or larger.

x ***No cutting of any tree that has exposed roots visible in the streambank.***

Extra Requirements to Harvest in Zone 2 (10 to 50 feet)

- Harvest no more than 50% of the trees that are larger than 5" DBH.
- Remaining trees in Zone 2 must be as evenly spaced apart as possible.
  Re-entry for natural forest is allowed every 15 years.
  Re-entry for plantation forest is allowed every 5 years.

Harvesting in Zone 3 (50 to 100 feet, or 50 to 200 feet)

- All timber may be harvested and forest regeneration is allowed, provided that groundcover is established and maintained to provide for diffusion and infiltration of surface runoff.

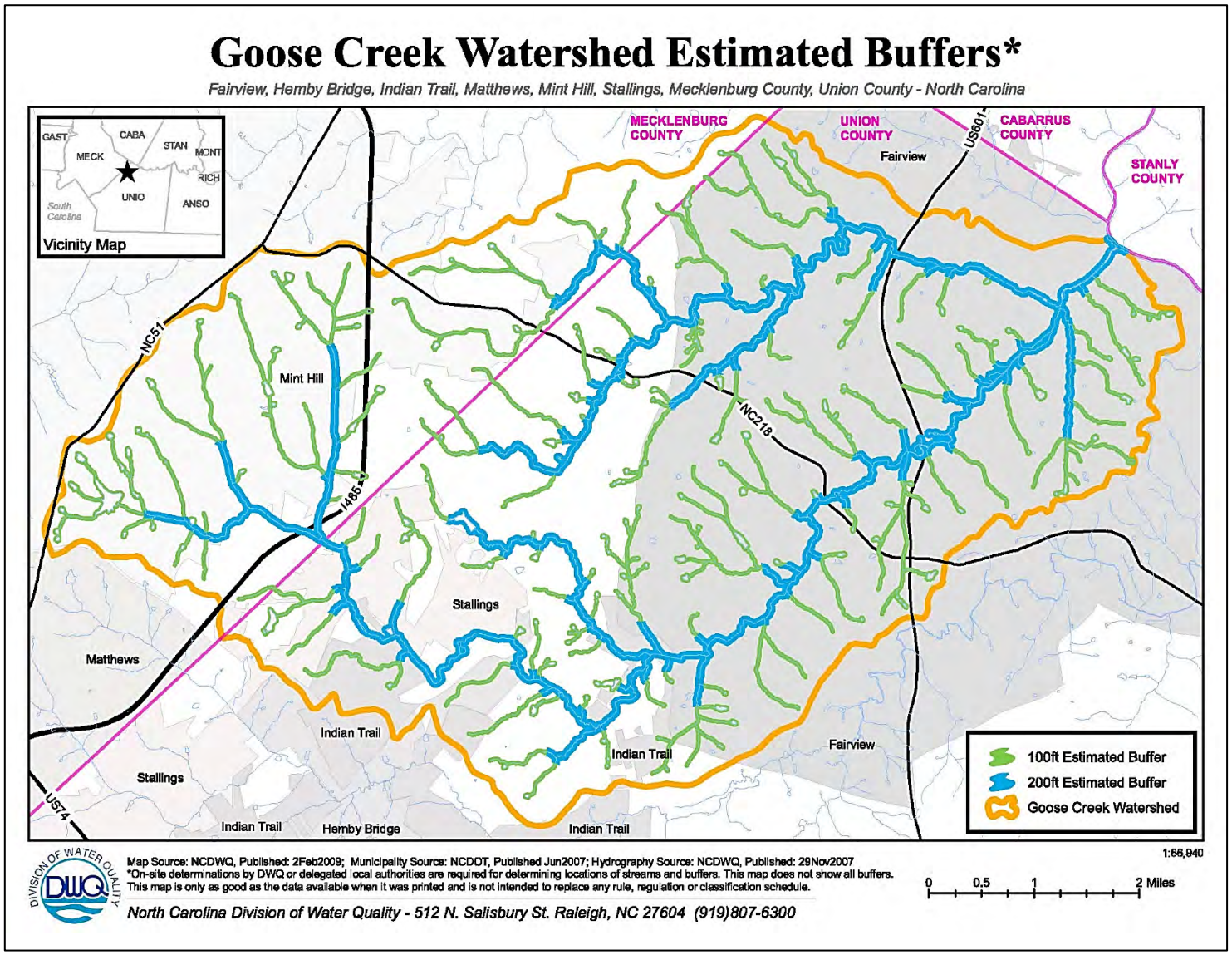
5. Other Forest Management Activities in the Entire Buffer Rule Zone

Allowed

- ✓ Individual trees may be treated to maintain or improve their health, form, or vigor.
- ✓ Removal of individual trees that are in danger of causing damage to structure or human life.
- ✓ Natural regeneration of forest vegetation, and planting of trees, shrubs or ground cover; provided that soil disturbance is minimized.

Allowed with Restrictions

- Harvest of dead or infected trees or application of pesticides as necessary to prevent or control the spread of tree pest and disease infestation. Must be approved by the NCFS, and the NCFS must notify the NC-DWR within 60 days.
- Prescribed burns are allowed when conducted for forest management purposes.
- A one-time fertilizer application at agronomic rates to establish replanted vegetation. No runoff from the fertilizer application is allowed into surface water.



North Carolina Forest Service

FORESTRY Leaflets

December 2020 WQ-12

A Guide to Implementing the Jordan Lake Water Supply Watershed Riparian Buffer Rules for Forest Management Activities

Effective August 11, 2009, N.C. rule 15A NCAC 2B .0263 through .0273 and .0311(p) requires protecting and maintaining riparian areas along waterbodies located throughout the Jordan Lake watershed. This watershed includes the three tributary subwatersheds known as the Upper New Hope, the Lower New Hope, and the Haw River arms of the Jordan Reservoir (see map on Page 4). Contact the N.C. Division of Water Resources (DWR) Raleigh or Winston-Salem Regional Offices.

Where To Apply This Riparian Buffer Rule

This rule applies to perennial streams, intermittent streams, ponds, lakes, and reservoirs located in the Jordan Lake Water Supply Watershed if it is approximately shown on any of the following references:

- It appears on the most recently published version of a USGS 1:24000 ("7.5 Minute Quad") topographic map.
- It appears on the most recent published version of a USDA-NRCS Soil Survey manuscript map.
- Other maps approved by the Environmental Management Commission (EMC) as more accurate than those identified above.

The Jordan Lake Water Supply Watershed Riparian Buffer Rules do not apply to the following waterbodies:

- ✗ Any "surface waters" that do not appear on any of the referenced maps.
- ✗ Any ephemeral streams.
- ✗ Ditches or other man-made water conveyances, other than modified natural streams.
- ✗ Man-made ponds and lakes that are located outside natural drainage ways.
- ✗ Areas mapped as intermittent streams, perennial streams, lakes, ponds, or reservoirs on the most recently published versions of either a USGS 1:24000 scale topographic map or NRCS soil survey map where no perennial waterbody, intermittent waterbody, lake, pond or reservoir actually exists on the ground. This type of determination must be made by DWR or by those to which they have delegated that authority.

- Seek advice from a professional certified in DWR's "Surface Water Identification Training and Certification Program" when determining this rule's applicability. The NC Forest Service has personnel that are certified through this program for making determinations in forestry situations.
- Modified streams may look like ditches, but still require implementing these watershed buffer rules. This leaflet is not intended to provide legal advice or final interpretation of the Jordan Lake Water Supply Watershed riparian buffer rules.
- On waterbodies where the Jordan Lake Water Supply Watershed riparian buffer rules do not apply, a Streamside Management Zone (SMZ) of appropriate width is still required to comply with the Forest Practices Guidelines Related to Water Quality (FPGs).
- There may be additional requirements of the Jordan Lake Water Supply Watershed Riparian Buffer Rules not covered in this Leaflet with which forestry activities must comply.

How To Measure the Required Buffer Width

For streams: Measurement will "begin at the top of the bank and extend landward" and "on all sides of the surface water, measured horizontally on a line perpendicular to a vertical line marking the top of the bank."

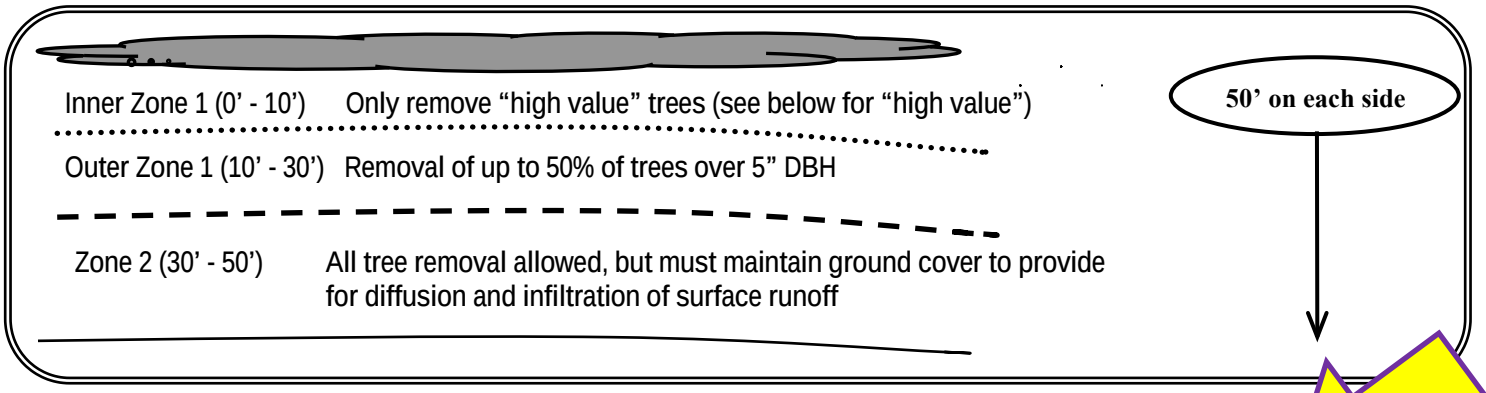
For other waterbodies: Measurement will "begin at the normal water level and extend landward" and will be "measured horizontally on a line perpendicular to a vertical line marking the normal water level."

Required Riparian Buffer Widths and Zones

The buffer area is made up of two zones that together are 50-foot wide around all sides of the waterbody

Zone 1: The closest 30 feet from the edge of the waterbody extending towards land. Zone 1 is subdivided into two areas that have different selective harvesting requirements. See illustration below.

Zone 2: The next 20 feet towards land, extending from the end of Zone 1.



Timber Harvesting In The Jordan Lake Watershed Riparian Buffer

Timber harvesting is only allowed to occur in Zone 1 (30 feet closest to the stream or waterbody) of the buffer if:

1) A forest management plan for the property is prepared, **or**
2) The property is enrolled in that county's Present-Use Tax Valuation Program for forestry use.

Zone 1 - Inner 10 feet: 0 to 10 feet (land immediately adjacent to the stream or waterbody)	
Allowed	Selective harvest of individual "High Value" trees. Trees shall be removed with minimum disturbance to soil and residual vegetation.
Allowed with Restrictions	• "High Value" Pine trees are defined as any tree with a Diameter Breast Height (DBH) of 14" and greater, **or** a stump diameter of 18" and greater. • "High Value" Hardwood and Wetland trees are defined as any tree with a DBH of 16" and greater, **or** a stump diameter of 24" and greater.
Prohibited	• No removal of any tree with exposed primary roots visible in the streambank. o Unless listed as an exempt activity under Vegetation Management in the Table of Uses, Sub-Item (9) of this Rule. o It is recommended to mark/flag residual "leave" trees to make sure they are protected. • No soil-disturbing site preparation activities.

Zone 1 – Outer 20 feet: 10 to 30 feet (land adjoining the inner 10 feet area)	
Allowed	• Selective harvest is allowed. Trees shall be removed with minimum disturbance to soil and residual vegetation. • Remaining trees left standing should be as evenly spaced as possible.
Allowed with Restrictions	• Tracked or wheeled vehicles are permitted for the purpose of selective timber harvesting where there is no other practical alternative for removal of individual trees and provided that activities comply with North Carolina FPGs. • Harvest of no more than 50% of the trees over 5" DBH: o Re-entry for natural forests is allowed every 15 years. o Re-entry for forest plantations is allowed every 5 years.
Prohibited	• No removal of trees 5" DBH and smaller. • No soil-disturbing site preparation activities.

All of Zone 2: 30 to 50 feet (The outermost 20 feet of the entire riparian buffer)	
Allowed	Harvest and regeneration of the forest stand is allowed, so long as there is sufficient ground cover maintained to provide for diffusion and infiltration of water runoff. **All activities must still comply with the FPGs.**

Forestry Activities In The Riparian Buffer

Required in the Entire 50-foot Riparian Buffer

- Diffuse flow of water shall be maintained in the riparian buffer by dispersing concentrated runoff flow and re-establishment of vegetation.

- Concentrated runoff from new ditches or man-made conveyances shall be converted to diffuse flow before the runoff enters Zone 2 of the riparian buffer.

- Periodic corrective action to restore diffuse flow shall be taken as necessary and shall be designed to impede the formation of erosion gullies.

- No new stormwater conveyances are allowed through the buffers except for those specified in Item (9) of this Rule addressing stormwater management ponds, drainage ditches, roadside ditches, and stormwater conveyances.

Forestry Activities Allowed in the Entire 50-foot Riparian Buffer

- Individual trees may be treated to maintain or improve their health, form, or vigor.

- Harvesting of dead or infected trees or application of pesticides necessary to prevent or control extensive tree pest and disease infestation. These practices must be approved by the NC Forest Service for a specific site. The NC Forest Service must notify the Division of Water Resources of all approvals.

- Removal of individual trees that are in danger of causing damage to structures or human life.

Forestry Activities Allowed with Restrictions in the Entire 50-foot Riparian Buffer

- Access roads and skid trails only allowed for temporary and permanent stream crossings, which are established in accordance with FPG .0203. Temporary stream crossings shall be permanently stabilized after any site disturbing activity is completed.

- Timber felling shall be directed away from the stream or waterbody.

- Skidding shall be directed away from the stream or waterbody and shall be done in a manner that minimizes soil disturbance and prevents rutting or the creation of channels.

- Natural regeneration of forest vegetation and planting of trees, shrubs, or ground cover plants to enhance the buffer shall be allowed provided that soil disturbance is minimized.

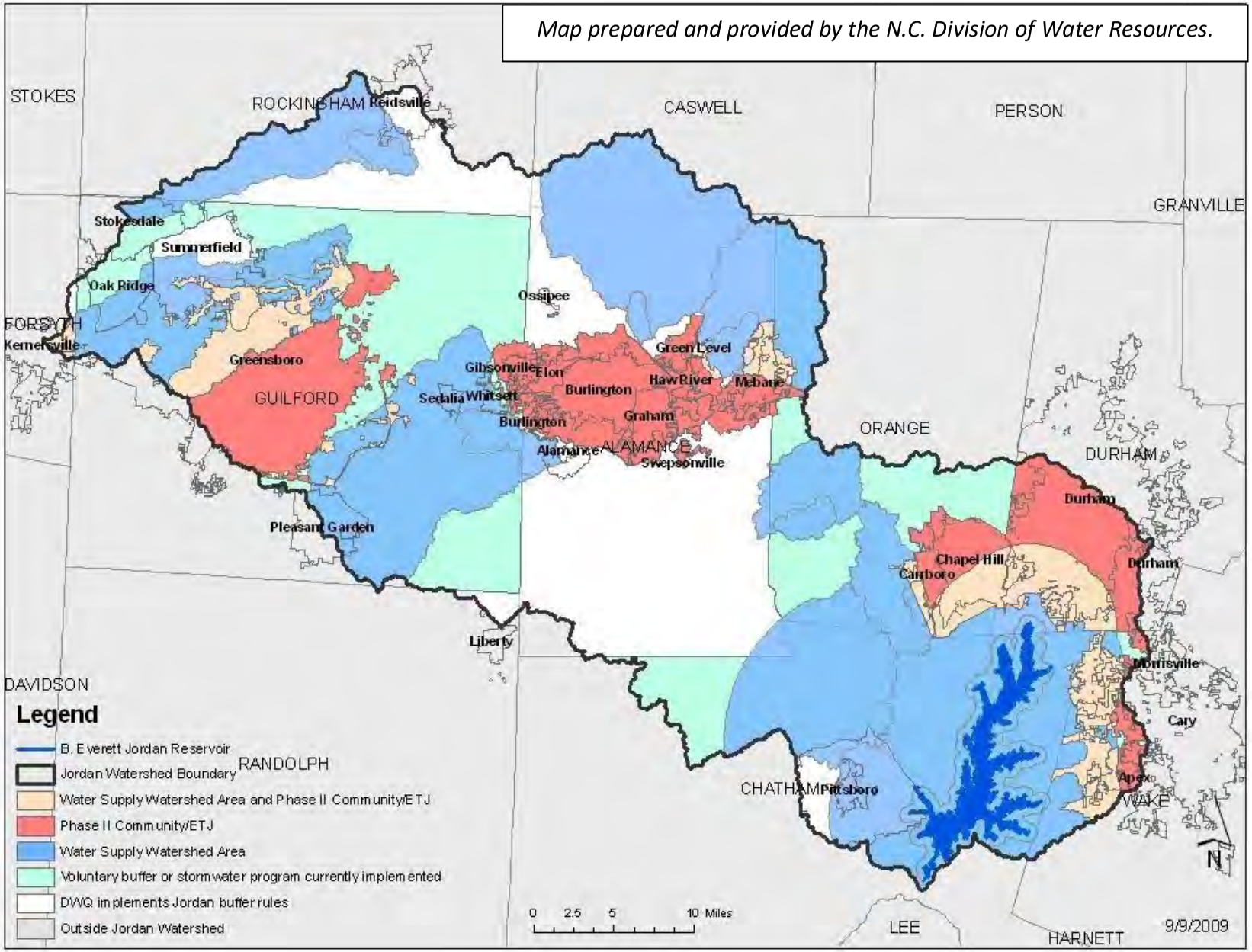
- Application of fertilizer only allowed as necessary for permanent stabilization. Broadcast application of fertilizer or herbicides to the adjacent forest stands shall be conducted so that the chemicals are not applied directly to or allowed to drift into buffer.

Forestry Activities Not Allowed in the 50-foot Riparian Buffer

× NO logging decks or sawmill sites placed in the buffer.

× NO high intensity prescribed burns.

Map prepared and provided by the N.C. Division of Water Resources.



Index of Topics

"A Note On…" Topics Index

Emergency Contact Information

Poison Control / Treatment -- *call 911 for life-saving help*

Carolinas Poison Center — www.ncpoisoncenter.org
1-800-222-1222

Reporting Oil, Fuel, Petroleum and other Chemical Spills

NC-DEQ Regional Offices — https://deq.nc.gov/

Asheville	(828) 296-4500	Washington	(252) 946-6481
Fayetteville	(910) 433-3300	Wilmington	(910) 796-7215
Mooresville	(704) 663-1699	Winston-Salem	(336) 776-9800
Raleigh	(919) 791-4200		

NC Division of Emergency Management State Operations Center
1-800-858-0368

National Response Center for major spill reporting
1-800-424-8802

Pesticide Handling and Application

State Rules: N.C. Dept. of Agriculture and Consumer Services,
Pesticide Section: (919) 733-3556

General Information: National Pesticides Information Center
1-800-858-7378

Sedimentation and Erosion Control Complaints

NC-DEQ Division of Energy, Mineral and Land Resources, Land Quality Sect.:
1-866-STOPMUD (786-7683)

Inconsistent Forestry Practices

North Carolina Sustainable Forestry Initiative (SFI) Monitoring Hotline
1-877-271-6531