Chapter 1
Introduction to Best Management Practices and Soil Factors

Chapter 1 Layout:

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For Forest Owners:

Examples of forestry activities that should use BMPs:

- *Chemical application, which includes fertilizer and herbicide*
- *Drainage alterations*
- *Prescribed burning*
- *Road construction and maintenance*
- *Site preparation for forest regeneration*
- *Timber harvesting*
- *Timber stand improvement*
- *Tree planting*
- *Wildfire control*
- *Wildlife habitat improvement*

Part 1 -- Why Best Management Practices?

Properly managed forests are crucial for stabilizing soils, protecting watersheds and producing high quality water. 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 includes 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 means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals." *<end citation>*

Water Quality Link

Water quality can be influenced by changes in sediment load, nutrient levels, water temperatures, stream flow, chemicals and dissolved oxygen.

BMPs, or other suitable practices, should be planned ahead of time with careful design and implementation, because:

- Taking this time beforehand will improve the chances of success.
- Maintenance and periodic follow-up are needed to insure the BMPs continue to function.
- Stabilization of the site is considered a BMP itself, and should be planned for accordingly, and not left until the very end.

The overall goal is to protect the biological, chemical and physical integrity of the water.

Part 2 -- The BMP Process

Using BMPs can be thought of as a multi-step process:

1)Planning 2)Implementing 3)Stabilizing 4)Maintaining

Also Refer To…

Chapter 3 outlines what steps to take when planning a forestry operation.

1. Planning

Planning will help you determine a site's conditions. Knowing these conditions and the type of operation you intend to conduct will determine the type and amount of BMPs that you should consider.

Part of planning includes knowing and understanding the rules, laws and other required practices that may apply to your forestry operation. Chapters 2 and 6 explain many of these required practices, while the Appendix includes citation of applicable rules, laws or regulatory guidance documents.

2. Implementing

Correcting implementing BMPs will promote effectiveness and efficiency.

3. Stabilizing

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Stabilizing critical disturbed soil areas is important to assure long-term water quality protection. In many cases, site stabilization can begin even while the operation is still active, by retiring or putting to bed those areas on the job site that no longer have any activity.

4. Maintaining

Maintaining the BMPs once you have put them in place will assure they continue to function.

Part 3 -- The Runoff Process

Did You Know?

It is common for the greatest amount of runoff to take place from just a few major rainstorms.

This means your operations may need to be adjusted or halted if significant precipitation is expected.

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 no longer has the ability to absorb water through its surface.

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 appropriately, 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:

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

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.

Sediment Control

Watch Out!

In North Carolina, sedimentation is the most frequent water quality concern associated with forestry operations.

BMPs that keep the soil in place and retain the soil's structure can also protect water quality from other potential pollutants.

Sediment is created when runoff and erosion washes soil into a waterbody. While sedimentation is a natural process, too much can cause problems. As a result, a main focus of most BMPs is to control sediment.

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, forest management activities can be completed in ways that minimize soil disturbance, slow surface water runoff and maintain the soil's ability to absorb and store water.

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

Table 1-1 below gives a simplified example of the relative costs for implementing, or putting into place, certain BMPs for controlling sediment.

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

In many cases the lowest cost BMP to implement can be the most effective in controlling sediment and protecting water quality.

Another way to think about it:
If you don't mess it up, you don't have to fix it!

BMP	Relative Cost
Pre-harvest planning and job site layout. Minimize bare soil. Maintain groundcover.	$
Functioning SMZs and buffers. Bridgemats for stream crossings.	$$
Gravel, waterbars, broad-based dips, sediment traps, silt fences, culverts, straw bales, turnouts.	$$$
Having to stop your work and fix a problem. Returning to a site for stabilization *after-the-fact.*	$$$$$

Importance of BMPs Hydrologic Functions

Forests are among the best land use for protecting 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:

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1. Stream crossings 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 the water at a stream crossing, these locations have the highest potential for problems.

Also Refer To…

Specific BMPs for wetlands are found in Chapter 6.

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.

Did You Know?

Technically speaking, soil can be very difficult to compact.

However, for the purposes of this BMP manual, this term is used to describe the loss of inter-pore spaces between soil particles, which, in turn, influences hydrology and site productivity.

While the soil's chemical or physical structure may not change, the alterations that can occur may increase the risks to water quality.

A Note on Intensive Soil Disturbance

A universal BMP is to minimize the amount of soil disturbance. This is especially true for intensive soil disturbances that are often referred to with terms such as rutting, compacting, souping, mixing and/or churning.

Intensive disturbance to the soil alters the soil's structural properties, reduces air spaces between soil particles, creates underground blockages for water movement, and decreases the soil's ability to absorb precipitation.

When this kind of disturbance occurs, the hydrology of the site may be affected and runoff can increase. That is why it is important to keep this kind of disturbance to a minimum and rehabilitate areas that show signs of excessive disturbance, if doing so will improve hydrology and water quality.

In addition, a well developed, non-eroded forest soil has nearly 85 percent of the fine root system within the top 18 inches. In cases where trees will be left to grow after a partial harvest, it is important to avoid intensive soil disturbance, so the residual trees will still have their fine root systems intact.

Importance of BMPs Sunlight Intensity and Water Temperature

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

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Streamside Management Zones and riparian buffers not only are 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.

The goal of protecting the biological, chemical, and physical integrity of water includes using BMPs that provide suitable shade so sunlight intensity is not significantly increased along water areas that are shaded prior to forestry operations.

Excessive removal of shade 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.

For Forest Owners:

Forestry chemicals refers to fertilizer and pesticide.

Importance of BMPs 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.

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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 7 of this manual outlines additional BMPs to consider.

Did You Know?

Some examples of organic matter: Leaves, pine needles, logs, limbs, tree-tops, slabs, chips, bark, roots.

Importance of BMPs Organic Matter and Debris

Contribution of organic matter and debris by natural processes is important for the aquatic health of a waterbody. Organic matter is also a vital component of soil and is needed to maintain good conditions for soil-living 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 falling precipitation.

However, debris can block streamflow and damage the stream channel, which can then lead to accelerated erosion and sedimentation from the streambank.

In addition, if too much organic matter gets into the water, significant amounts of oxygen in the water can be consumed as the material decomposes. This creates poor living conditions for aquatic organisms.

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NOTE: Review the applicable FPG standards and N.C. General Statutes related to this subject. These are described in detail in Chapter 2.

Importance of BMPs Frozen or Surface-Hardened Soil

Soils that are either frozen or otherwise surface-hardened 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 natural soil temperature and allowing better water infiltration.

If a site has surface-hardened soil that is not frozen, it may be beneficial to disk, rip, or otherwise till the soil to improve water infiltration and movement.

Importance of BMPs Unique Soil Features in North Carolina

North Carolina has some unique soils that may require additional planning and BMPs for forestry operations:

For Forest Owners:

Many times these organic / muck soils are located in or near wetlands. On these soils, it may be suitable to use the BMPs for forested wetlands in Chapter 6.

Shrink / swell soils exist across an area of the piedmont and foothills of North Carolina known as the Triassic Basin.

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 earlier in this chapter. Additional measures may be needed to control runoff.

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 usually be linked to some key landscape and soil factors, some you have control over, such as slope length, and others that you may not, such as soil texture.

Understanding how these factors relate to each other can help you determine what kind of BMPs to use.

LANDSCAPE Factor Slope Steepness and Length

Did You Know?

Runoff from a steep slope over a short length may have the same long-term effect as a flatter slope that runs for a long distance.

Steeper slopes allow runoff to build up more speed and erosion force. Slope length can also play a role in determining runoff amounts.

In either case, select the right BMP for the site conditions. For example:

- A short, steep slope on a skid trail or fireline may require more waterbars.
- Longer, shallower slopes on an access road may need broad-based dips.

A general guide to follow regarding slope steepness is shown in Table 1-2:

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%

Did You Know?

Generally, sandy and loamy soils absorb water faster than heavier soils like silt or clay.

However, the silt and clay soils typically retain soil moisture for a longer period.

SOIL Factor Texture

Soil texture can influence how much a soil is prone to erosion and how much water infiltrates into the soil.

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

- A soil with high erosion potential will likely require even 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 not be a risk.

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

SOIL Factor Infiltration Capacity and Water Absorption

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 soil is altered or excessively disturbed, the water may not move as well.

Some examples of situations that allow good water infiltration, absorption and internal water movement include:

- Maintaining adequate organic matter and groundcover on the soil surface.
- Avoiding intensive soil disturbance.
- Tilling areas of intensive soil disturbance and providing groundcover to increase infiltration and slow runoff.

SOIL Factor Structure

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

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.

For Forest Owners:

If pore spaces are decreased, tree seedling roots can have a more difficult time establishing themselves, especially in heavy or droughty soils.

SOIL Factor Moisture Content

Soil moisture content 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.

Practices that can address moisture content 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.
- 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.

Did You Know?

Water infiltration is usually highest in a slightly moist, loose soil.

It can be difficult for water to soak into a soil that is already saturated, or is extremely dry and surface-hardened.

Chapter 1 Summary

Best Management Practices are important tools to protect the biological, physical and chemical characteristics of water quality. In North Carolina, Forestry BMPs should be used to help you meet the performance standards defined by the *North Carolina Forest Practices Guidelines Related to Water Quality*. Compliance with the FPGs will allow a forestry job site to retain the forestry exemption under the state's Sedimentation Pollution Control Act.

Recognizing major landscape and soil factors that influence the choice and use of BMPs can assist you with planning and conducting a forestry operation in a way that protects water quality, wetlands and soil characteristics in an efficient and effective manner.

This manual provides specific Forestry BMPs that:

- ✓ Minimize bare soil area and disturbance.
- ✓ Protect waterbodies.
- ✓ Control surface water runoff.
- ✓ Maintain groundcover.

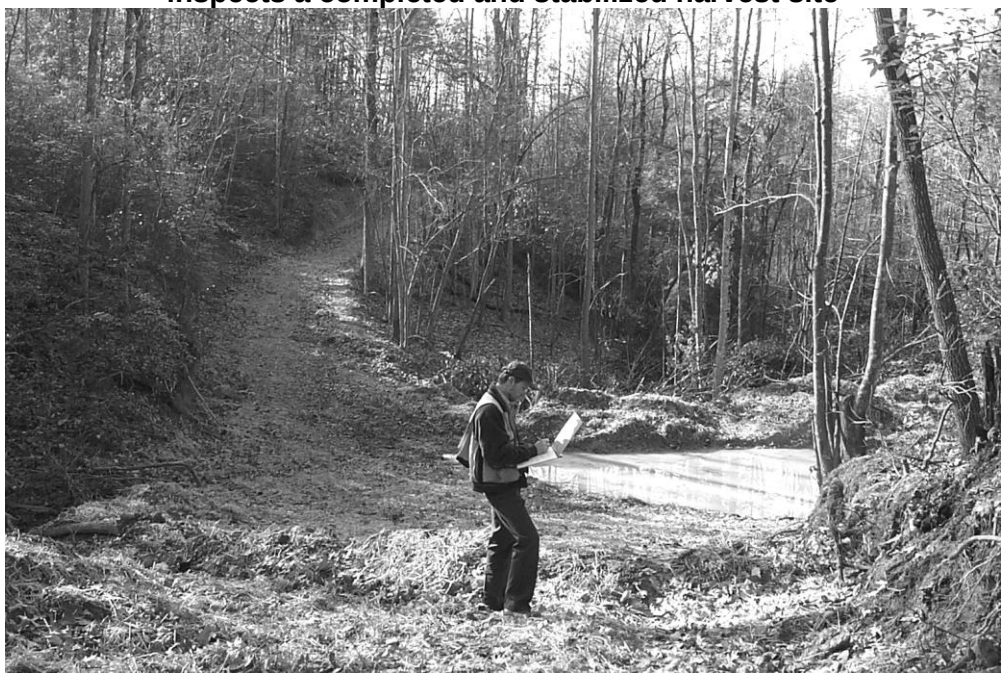
You can obtain technical assistance about soil from local offices of the USDA-Natural Resources Conservation Service or state Soil & Water Conservation District, as well as other natural resources professionals.

Need Help?

Most county NRCS and SWCD offices have soil survey maps containing detailed soils information.

See Appendix 2 for county NRCS and SWCD phone numbers.

Figure 1A: A N.C. Forest Service Water Quality Forester inspects a completed and stabilized harvest site



Caption:

The N.C. Forest Service can inspect your site before, during, and after the forestry operation to assist you with BMPs.

Some BMPs to note in this photo:
- Road grade cut-in along the land contour.

- Seeded and mulched bare soil areas.

- Sediment catchment to trap runoff and allow sediment to settle out.