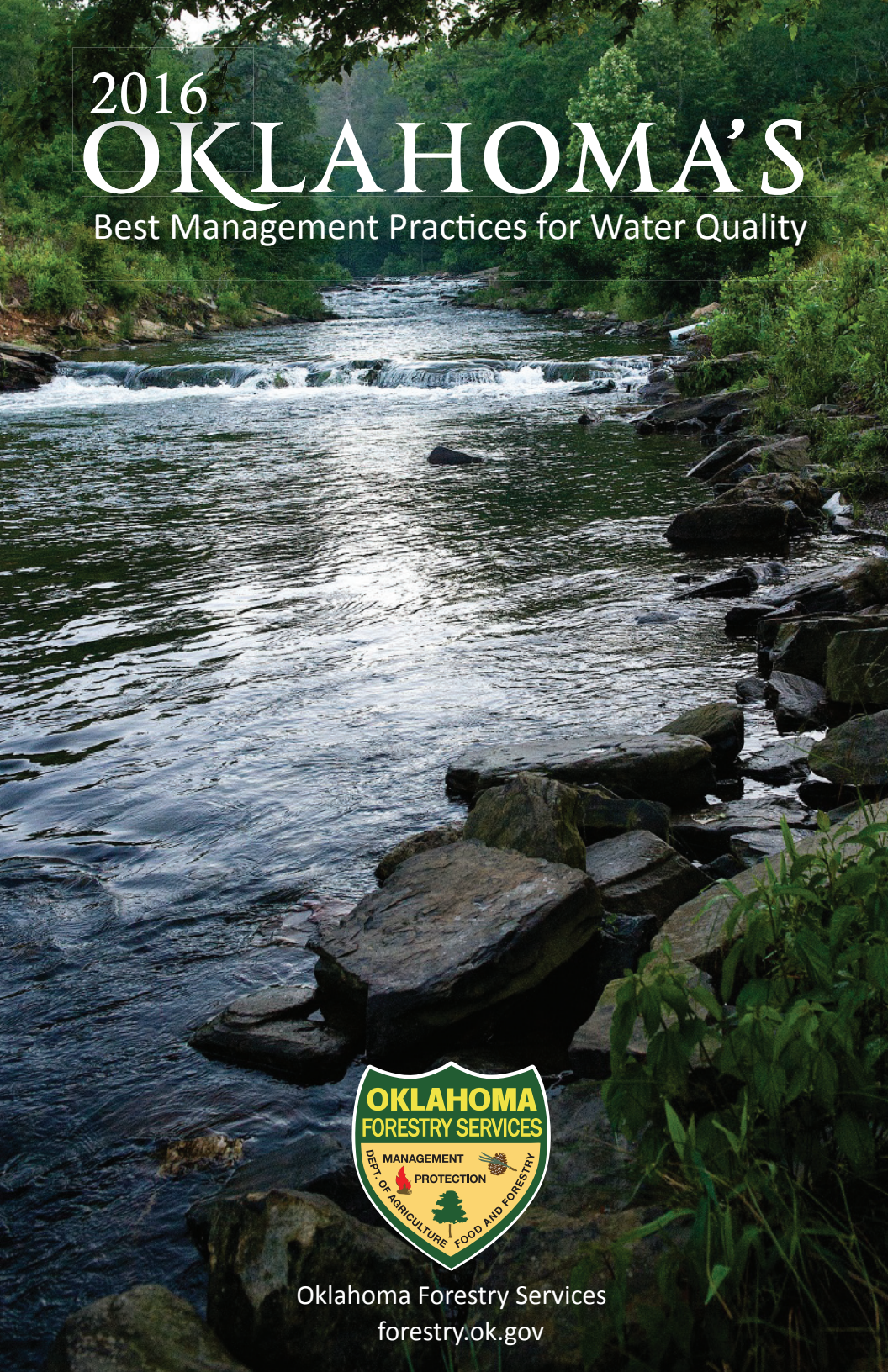

2016 OKLAHOMA'S

Best Management Practices for Water Quality

Oklahoma Forestry Services
forestry.ok.gov

Forestry Best Management Practice Guidelines for Water Quality Management in Oklahoma

Foreword

Oklahoma Forestry Services'(OFS) purpose is to conserve, enhance and protect our state's forest resources for present and future generations. While working to accomplish this mission we continuously strive to balance our landowner's needs with the protection of forests, water quality and the value of the other services and products these forests provide such as wildlife habitat, clean air and aesthetics.

OFS is mandated by state statute to "administer silvicutural best management practices in cooperation with forest land users under the provisions of state and federal water pollution laws." (O.S. Title 2, Article 16, Section 16-3) but has chosen to partner with landowners and forest industry to develop and implement best management practices for water quality thereby ensuring compliance with all state and federal laws and regulations.

Since 1976, Oklahoma's Best Management Practices (BMP) program has included written guidelines, routine monitoring and education for landowners, loggers, industry foresters and consultants. The program is routinely updated to provide for changing prescriptions, standards and regulations.

Oklahomans see these guidelines as an unobtrusive and acceptable way to protect our natural resources. On-site judgment and common sense insure that water quality standards are maintained. The most important guidance these BMPs offer the forestry community is to think and plan before you act avoiding unnecessary site disturbance or damage, and minimizing the expense of stabilizing or restoring disturbances when the operation is finished.

Through voluntary application of Oklahoma's Forestry BMP Guidelines, we provide better results than a costly regulatory program would provide. Carrying out forestry practices properly ensures that our forests continue to meet the objectives of their owners, while also providing jobs, forest products, clean water and a healthy environment for the state's citizens.

We encourage consulting these guidelines before and during any silvicutural activity. Working together we will provide for a better Oklahoma.

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Introduction

Oklahoma's 12 million acres of forests provide important public benefits, including plentiful supplies of clean water, wildlife habitat diversity, scenic beauty and recreational opportunities. Our forest products industry annually contributes an estimated $4.5 billion in direct and indirect value to the state's economy, and employs more than 18,000 people with $738 million in wages and salaries. As the population of Oklahoma and the region grows and becomes more urbanized, our forestlands can expect greater scrutiny as a source for additional supplies of clean water. All forestland owners and users have an obligation to protect the quality and sustainability of water resources from Oklahoma's forestlands.

Timber harvesting, site preparation, forest road construction and maintenance and other forestry practices can affect water quality. However, by following the guidelines described here, landowners may harvest timber products as well as manage and enjoy their lands with minimal impact on water quality.

The Federal Water Pollution Control Act of 1972 mandated the quality of the Nation's waters would be protected from degradation and that all waters would be made fishable and swimmable. The Clean Water Act Amendments of 1977 expanded federal jurisdiction so the law covered *the waters of the United States and their adjacent wetlands*. Section 208 of the Act required states to develop water quality management plans and to address non-point sources of pollution, including forestry.

Forestry Best Management Practice Guidelines (BMPs) are an important part of Oklahoma's non-point source management program. The BMPs are intended (1) to supplement the technical BMPs on forest practices and road construction contained in the State Water Quality Management Plan, and (2) to provide guidance to forest owners, operators and government agencies for BMP implementation.

The following guidelines are based upon Oklahoma's original *BMPs Concerning Forestry and Water Quality in Oklahoma*, which was developed by a blue ribbon forest practices committee appointed by Governor David L. Boren in 1976. The guidelines are based upon research findings and practical experience, and are subject to change as practices are improved or refined.

For the most part, Oklahoma relies on a non-regulatory approach to BMPs. However, forest road practices and certain site preparation practices *associated with wetlands* must follow the Mandatory BMPs prescribed by the Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (page 50). The forestry community's compliance with these guidelines is essential for continued freedom and flexibility to practice forestry without restrictive government regulation.

BMP Compliance

Practices applied in accordance with these guidelines will constitute "Best Management Practices" and generally satisfy water quality protection standards of a variety of forest practice evaluation programs. Industrial owners use the BMPs to ensure that its operations meet requirements under the Sustainable Forestry Initiative™ (SFI) and similar forest certification programs. The American Tree Farm System's™ inspectors use the BMPs to certify that recognized Tree Farms meet water quality objectives. Oklahoma Forestry Services considers the BMPs when certifying landowners as "Forest Stewards."

Although Oklahoma's forestry BMPs are *non-regulatory* in nature, Forestry Services use them to evaluate overall BMP implementation following a monitoring protocol developed by the Southern Group of State Foresters. Forestry Services conducts BMP compliance monitoring to (1) improve its logger education program, (2) identify problem areas needing correction or focused attention, (3) refine the BMP guidelines, and (4) document overall trends in implementation.

Occasionally, on-site monitoring identifies a "significant risk" to water quality that may require follow-up remediation by the landowner or contractor to avoid the risk of a water quality standards violation. Most of these incidences occur where the Forestry BMP Guidelines were ignored or implemented incorrectly. Forestry Services' water quality forester is available to provide on-site recommendations to help the landowner eliminate these risks to water quality. A proactive approach is important to help the state maintain a non-regulatory approach to forest water quality management.

The Mandatory BMPS

Although the Federal Clean Water Act and regulations of EPA and the Corps of Engineers recognize the validity of State BMP programs, in certain circumstances BMPs for some forestry activities are mandatory. If planning to construct or make improvements to a forest road or road segment located in a federal jurisdictional wetland or that cross any "waters of the U.S.," including streams, sloughs, marshes or bogs, it is necessary to consider whether a federal Clean Water Act Section 404 permit will be required prior to initiating the work. Under the terms of Section 404, forest roads necessary to practice normal silviculture that is part of an established, ongoing operation are exempt from Section 404 permitting requirements, as long as they are constructed in accordance with the 15 Mandatory BMPs prescribed in Corps regulations. Corps regulatory guidelines in 33 CFR 323.4(a)(6) apply to "waters of the U.S.," not just wetlands. Therefore, forest road stream crossings under Corps jurisdiction for roads built in non-wetlands are also subject to the 15 Mandatory BMPs. Roads constructed in a forest environment for other purposes, such as recreational access, businesses or homes, or to prepare a tract for development are not exempt from 404 permitting. The mandatory BMPs are discussed in Part 9.

A few general conditions underlie compliance with the CWA and the Section 404(f) exemptions:

- To be regulated under Section 404, the planned road construction or improvement activity must result in a discharge of a pollutant (sed-

iment, debris, oil, pesticides, fertilizers, etc.) into waters of the U.S., which includes perennial and intermittent streams, sloughs, marshes, bogs, wetlands and similar areas. Forestry BMPs should be implemented in a way that prevents, minimizes or limits discharges.

- To be exempt from Section 404 regulation, the forest road must be a necessary part of a normal ongoing (established) silviculture operation; an operation intended to produce timber products through time.
- To be exempt, the road construction or improvement activity must not result in the immediate or gradual conversion of the forested wetland to upland or to another land use (e.g. urban or agriculture) or different wetland type (e.g., open water or marsh).
- Exempt roads must comply with the 15 mandatory BMPs listed in the Section 404 regulations.

State BMP programs are influenced by court decisions, legislation and agency rules and regulations and are subject to change. Contractors, landowners and natural resource managers should be aware of changes in law or policy governing their operations.

Oklahoma's Forestry Best Management Practice Guidelines

Oklahoma's BMPs are organized in nine major categories. The recommendations in these sections constitute Oklahoma's Forestry BMP Guidelines. Supporting materials are included in a glossary and lists of references and other resources in the appendix.

Part 1. Management and Compartment Planning
Part 2. Streamside Management
Part 3. Forest Roads
Part 4. Timber Harvesting
Part 5. Site Preparation
Part 6. Application of Forest Chemicals
Part 7. Fire Management
Part 8. Equipment Operation, Maintenance and Cleanup
Part 9. Wetlands
Part 10. Glossary
Part 11. Appendices

Part 1. Management and Compartment Planning

Introduction

Forest ownerships in Oklahoma vary in size, configuration, forest cover, accessibility and landowner objectives. Appropriate land management plans will vary accordingly. Regardless of type of ownership, advance planning of forestry activities and layout of stands with erosion prevention and water quality concerns in mind can contribute significantly to minimizing adverse environmental impacts. A logical order in carrying out practices is:

1. Planning and layout of harvest areas and access;
2. Road location, construction and maintenance;
3. Harvest, including landings and skid trails;
4. Site preparation, including prescribed burning;
5. Reforestation; and
6. Follow-up silvicultural and forest protection treatments, including use of forest chemicals.

The guidelines in this section focus primarily on the first item, because this activity establishes the physical on-the-ground pattern for most of the forestry practices that follow. Planning of harvest operations should also consider future silvicultural treatments and fire protection access.

Harvest unit layout and timber harvest operations that maximize efficiency, while protecting soil productivity, generally will protect water quality as well. Recommended practices include:

- Use available topographic maps, aerial photographs, soil surveys, Geographic Information System (GIS) data and other relevant sources of information. Combine these with local knowledge and on-site reconnaissance to ascertain on-the-ground conditions.
- When practical, use perennial streams as harvest unit boundaries, and plan skidding routes away from these streams and the SMZs protecting them (Part 2).
- Locate harvest unit boundaries to take advantage of natural and man-made elements of the unit and avoid problem areas. Locate log decks to minimize skidding distances, steep slopes and sensitive areas. Lay out harvest units to optimize economic skidding distances to minimize road densities and unnecessary road construction, as well as efficient establishment and management of subsequent forest crops.
- On wet or poorly-drained soils with seasonal water problems, schedule the timing of operations to minimize adverse impact on soils and water quality.

Non-industrial private forest landowners should consider developing a long-range forest management plan in consultation with a professional forester and seek their guidance prior to a timber harvest or before undertaking any major land-disturbing activity on their property.

- **Avoid leaving narrow, unmanageable strips of timber that may be susceptible to wind throw and other storm damage.**

Part 2. Streamside Management

Introduction

Proper streamside management is one of the most effective practices to maintain water quality. Forest management adjacent to water bodies should be applied with specific attention to measures that can be taken to protect water quality. Care is needed during road construction and harvesting to protect streams and streambanks from erosion. With proper management, the two objectives of timber production and protection of water quality can be achieved.

The most important considerations within the Streamside Management Zone (SMZ) – the strip of land left between streams and disturbed areas – are to minimize soil disturbance and maintain and protect the streambed and streambanks. Vegetation and land buffers protect streambanks and stream channels from erosion, maintain stream temperature and filter sediment and nutrients from disturbed areas. Harvesting of trees within an SMZ is acceptable and does not reduce its effectiveness, so long as the integrity of the SMZ is maintained, soil disturbance is minimized and the streambanks are avoided. SMZ failure can generally be traced to a source of concentrated flow from an upslope source. Eliminating these sources will greatly improve SMZ effectiveness. Professional judgment is critical in BMP application, especially within SMZs. Operate in accordance with the landowner's forest management plan, using the recommendations in this section.

Oklahoma's BMP guidelines differentiate between stream types. To remain in compliance with the BMPs, an operator must be able to distinguish between the types of streams most commonly encountered on forest sites.

Stream Classification

Streams are generally classified as perennial, intermittent or ephemeral. It is very important to recognize and properly classify each type to prescribe the appropriate SMZ and management practices. The definitions and characteristics of each type are described next and summarized in Table 1. When classifying a stream, look for the preponderance of the evidence and the overall risk that a forestry practice might impose on the stream.

Perennial Streams

A perennial stream is a watercourse with a well-defined channel and a continuous presence of water for more than nine months of the year under normal climatic conditions for the region (Figure 1). An SMZ is recommended along all perennial streams. Other identifying characteristics include:

- A floodplain exists on one or both sides of the channel.
- Bottomland and/or hydrophytic vegetation exists in the floodplain.
- The channel is made up of gravels, sands or other material transported and deposited by water (alluvium).

Table 1. Characteristics of Streams and Drainages.

Parameter	*Perennial*	*Intermittent*	*Ephemeral*
Presence of a well-defined channel	Yes	Yes	In most cases, no
Continuous presence of water	>9 months/year	3-9 months/year	No; only with rain events
Presence of flood floodplain/terrace structures	Yes	Possibly, but narrow	No
Identified on 1:24,000-scale USGS Topo Maps (most of the time, but not always)	Solid blue line, may be named	Alternating solid and dotted line	Not generally marked
Presence of pools of water	Yes, even during dry periods	Absent when dry	No
Presence of alluvial channel structures	Yes	Somewhat	Usually absent
Presence of leaf litter in flow channel	Absent	Absent	Sporadically Present
Bottomland/Hydrophytic vegetation is associated with the streambanks or floodplain.	Yes	Yes, but restricted to near the streambanks	No
Aquatic insects and fish are present in the stream	Yes	Yes, but more difficult to assess when dry	No
SMZ Recommended?	Yes	Yes	No

Part 2: Streamside Management

Figure 1. Example of a Perennial Stream.

- Pools of water are common along the watercourse, even during dry periods.
- Alluvium is deposited in well-formed structures, such as bars and riffles.
- In most (but not all) cases, perennial streams are named and will appear on USGS Topographic Maps (1:24,000 scale) as a solid blue line.
- There is evidence of fluctuating high water marks and/or sediment transport.
- Leaf litter is usually absent in the flow channel.
- Aquatic insects and fish are present.
- Watershed size is generally 300 acres or more in mountainous terrain.

Intermittent Streams

An intermittent stream is a watercourse with a well-defined channel that maintains seasonal water flow from three months to nine months of the year (Figure 2). An SMZ is recommended for an intermittent stream. Other identifying characteristics include:

- The stream may be identified on USGS Topographic Maps (1:24,000 scale) as alternating solid and dotted lines, but this designation should only be used as a guide.
- Water pools are absent during dry conditions but present during wet conditions, as long as ground water is abundant.
- Floodplains are narrow, poorly developed or missing.
- Bottomland and/or hydrophytic vegetation may be present, but limited in extent.
- In mountainous regions, the channel is composed mainly of large gravels, cobbles and boulders.
- Generally, there is evidence of fluctuating high water marks and/or sediment transport.

Figure 2. Example of an Intermittent Stream.

- Streambed structures such as bars and riffles may exist, but are not well-formed.
- Leaf litter is usually absent in the flow channel.
- Aquatic insects and crayfish may be present in the stream, but this can be difficult to assess during dry periods.
- Watershed size is generally 60 acres to 300 acres in the Ouachita Mountains, but size will vary across the state.

Ephemeral Streams

An ephemeral stream generally flows only during and shortly following a heavy rain or storm event (Figure 3). There is no recommendation to leave an SMZ along an ephemeral stream, although it may be appropriate where the channel is surrounded by steep breaks. Identifying characteristics include:

- In some cases, there is no well-defined or scoured channel (swales).
- In other places, a scoured channel with distinct banks is present (gullies and steep mountain channels).
- There is no floodplain present.
- Streamside vegetation is the same as on the surrounding land.
- Pools and formations formed by alluvium are absent.
- The drainage channel may or may not be identifiable on a topographic map.
- The channel or flow area is generally straight, rather than meandering.
- Leaf, twig and other forest litter is typically present or sporadically displaced.
- Watershed size is generally less than 60 acres in the Ouachita Mountains, but will vary across the state.
- Nature rarely exhibits distinct boundaries. When in doubt about where an intermittent stream stops and an ephemeral stream starts, leave an SMZ. Remember, some harvesting in SMZs is an appropriate activity.

Figure 3. Example of an Ephemeral Stream.

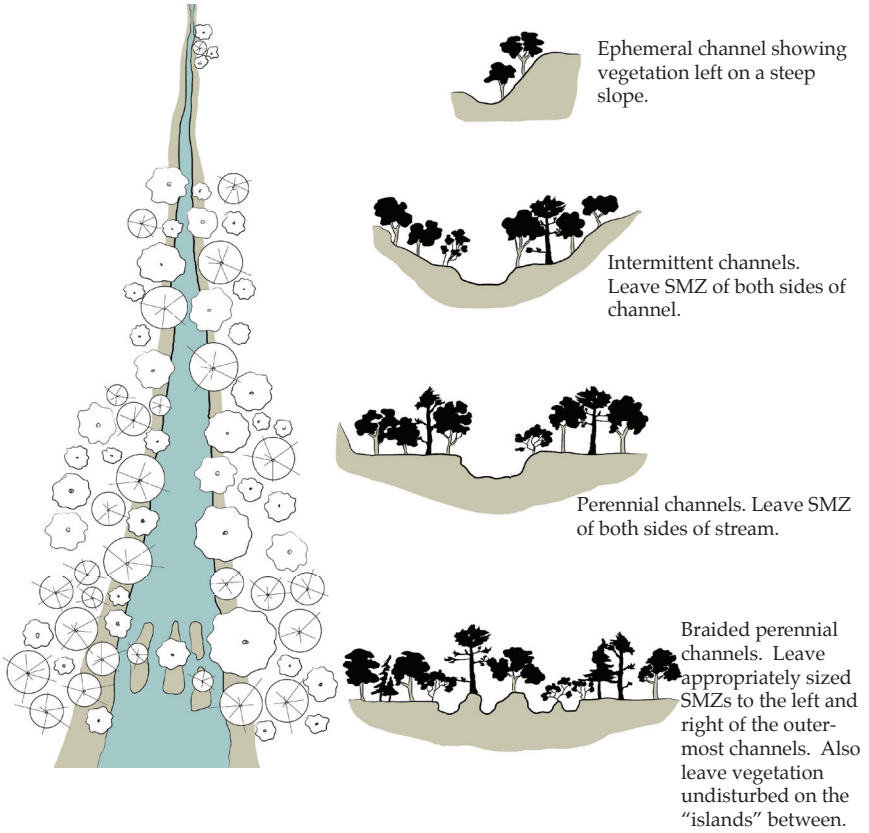

Figure 4. Typical SMZ Layouts and cross sections for ephemeral, intermittent, perennial and braided streams.

Recommended Minimum SMZ Width

- Designate an SMZ along each side of perennial and intermittent streams, and on other water bodies as appropriate. On slopes of less than 20 percent, SMZs should extend from both streambanks a minimum of 50 feet on perennial streams and 35 feet on intermittent streams, where local conditions permit. Figure 4 depicts typical SMZs on streams of various types.
- On slopes 20 percent and greater, wider SMZs may be appropriate and should be based upon professional judgment. Site conditions that may justify a wider SMZ include erodible soil type; presence of Outstanding Resource Waters, Scenic Rivers or public drinking water sources; floodplain and high water mark of the stream; or presence of ponds, pond dams, lakes or other sensitive areas.

Recommended Basal Area Retention within SMZs

- When thinning within an SMZ, leave a minimum of 50 square feet of basal area (BA) per acre. Leave all trees if less than 50 square feet of BA per acre is present. The concept of basal area is described below.
- Exceptions to the BA retention guidelines may be made where the owner is following a forest management plan and is intentionally converting the SMZ from a pine-dominated stand to a hardwood-dominated stand. A heavier thinning will accelerate the planned conversion. Follow the recommended BMPs, monitor the site for impacts and take corrective action if needed.
- When thinning, space "leave trees" as evenly as possible throughout the SMZ and minimize damage to the remaining trees.

Basal Area

An understanding of basal area is necessary to satisfy the recommendation concerning SMZs on perennial and intermittent streams and other water bodies,

Figure 5. Example of 50 ft^2 Basal Area of Mature Pine.

where appropriate. The term basal area is a measure of tree density or stocking, and is the sum of the cross-sections of all trees on an acre of land measured at DBH (4.5 feet above the ground). An example of 50 ft^2 basal area is shown in Figure 5.

An accurate estimate of BA can be obtained using a forestry tool called a "ten-factor prism." The term "ten factor" means that every "count" tree recorded at the center of a plot represents 10 square feet of BA. Used properly, it is simple to determine whether there are five or more "count" trees remaining at any point along an SMZ. It is also an invaluable tool when laying out the SMZ and deciding which trees to leave to meet the BA retention guidelines.

Recommended BMPs within SMZs on Perennial and Intermittent Streams

- Minimize disturbance to the forest floor.
- Leave all trees located on the streambank and protect bank stability. Removing a tree from the streambank may be acceptable in cases, where bank stability is at risk from a heavily leaning tree.
- Remove logging slash (tops and large limbs) from the stream channel.
- Do not use the stream channel as a roadway for any type of equipment or vehicle.
- On stream crossings, added material must be removed when logging is completed.
- Stabilize material removed from crossings and streambanks affected by the removal.

Recommended BMPs Associated with Ephemeral Streams

- Minimize discharges of sediment or other pollutants into ephemeral streams.
- Leave understory vegetation and non-merchantable material inside and along the edges of the drain, especially where erosion may be occurring.
- Mechanical site preparation should not disturb the channel.
- Do not discharge road runoff directly into ephemeral streams.
- Minimize soil exposure and compaction to protect ground vegetation.
- Do not construct landings in an ephemeral stream.
- On stream crossings, added material must be removed after logging is completed.
- Stabilize material removed from crossings and streambanks affected by the removal.

Avoid the Following Activities in Streamside Management Zones

- Harvesting trees overhanging a water body.
- Cutting trees growing on the streambank.
- Prescribed fires that burn to mineral soil.
- Locating portable sawmills or landings.
- Road construction except at crossings. If locating a road within an SMZ is unavoidable, employ BMPs to prevent direct run-off into the stream.
- Skid trails are discouraged, except at designated crossings.

- Felling trees into the streambed.
- Leaving logging debris in the stream.
- Mechanical site preparation.
- Mechanical tree planting.
- Broadcast application of herbicides.
- Application of fertilizers.
- Storage of chemicals, fuel, oil, etc.

Braided Streams

A braided stream is actually a stream system with multiple and frequently interconnected channels. Generally, these streams have a very low gradient (often less than ½ percent channel slope), broad valleys and well-defined floodplains. Treat each channel of a braided stream individually, depending upon whether the channel is perennial, intermittent or ephemeral. These stream systems require highly site-specific management planning and recommendations. In most cases, an SMZ is recommended that encompasses the entire system, incorporating the extreme channels on each side.

Lakes and Ponds

- For natural lakes, ponds and similar bodies of water (for example oxbow lakes, bayous and sloughs), follow the BMPs recommended for perennial streams if sediment or other pollutants have the potential to move off site.
- Treat beaver ponds as ephemeral (no SMZ is necessary).
- Treat manmade lakes and ponds according to the landowner's goals and objectives. SMZs on ponds used as water sources during firefighting operations are not recommended.

Seeps and Springs

Minimize soil disturbance (rutting, road building or mechanical site preparation) around natural seeps and springs, especially those used as a water source. Where these features are seasonal in nature, protection is generally not necessary.

Wetlands (Specific BMPs for wetlands are included in Part 9)

- **Avoid creating concentrated flows from adjoining harvest sites into SMZs.**
- **Avoid rutting or other soil disturbances near the channel.**
- **Avoid skidding within drains, except at planned crossings.**
- **Avoid locating roads in drains, except where necessary for well-planned crossings.**

Part 3. Forest Roads

Introduction

Well-located, well-constructed and properly maintained forest roads are essential to forest management activities and critical to reducing pollution impacts on forest streams and watersheds.

A forest road system consists of permanent and temporary roads that connect the forestlands to existing public roads. Permanent roads are intended to remain in use for an extended period, while temporary roads are used for a particular activity and are then retired. Forest roads that are improperly located, or poorly constructed or maintained can be the largest contributor of non-point source pollution from forestry activities. Forest roads located on steep slopes, erodible soils or stream crossings hold the greatest risk.

Existing Roads: Repair or Relocate?

Many tracts have existing roads and consideration must be made whether to use the current road system, or close it and construct a new road. Many existing roads are poorly designed and eroding, or have washed-out areas due to lack of maintenance. Many older roads do not meet the BMP guidelines for design or location. In making decisions, consider the effects of construction, continued use, maintenance requirements and landowner objectives. Seek professional help from experienced landowners, road engineers, government agencies, natural resource managers and researchers as needed.

The planned use of forest road BMPs should be based in large measure on the expected future use of the road and the owner's ability to maintain the road. The heavier the expected use and the less likely that follow-up maintenance will occur, the more time and effort should be devoted to installing more elaborate BMP systems.

Permanent Roads

Future forest operations will involve the use, rebuilding or upgrading of existing roads, and/or the construction of new roads. A road system that is well designed, well located and constructed and maintained in accordance with sound practices is essential to forest management. This section discusses these aspects and characteristics of forest roads. Choose the appropriate design standard and road location to achieve the best balance between costs and water quality objectives, including the following considerations:

Pre-Planning

- Identify Federal, State and local laws, regulations or ordinances that apply to the road purpose, construction and maintenance prior to construction and operation. Include needed considerations and measures to meet legal requirements.

- Use soil surveys, topographic maps and other resources to identify soils, stream locations and other natural features (rocky areas, steep slopes, wet areas, etc.) on the property that might pose problems.

Location

- Use the minimum design standard producing a road sufficient to carry the anticipated traffic load with reasonable safety and with minimum environmental impact.
- Minimize roads in narrow canyons, marshes, wet meadows and SMZs.
- Minimize the number of stream crossings.
- Locate roads away from streams as much as possible.
- Where practical, cross streams at right angles to the main channel.
- Where topography permits, locate roads along the crests of ridges. This practice minimizes excavation and locates roads away from streams.
- New permanent access roads should follow the contour of the land as much as possible with grades ideally kept below 10 percent. Grades may run up to 12 percent for short distances. If soil is highly erodible, reduce grades and increase the use of water control structures.
- Road spacing is dictated by need and costs more than BMPs. Road spacing and density should strike a logical balance between the variables of topography, soils, costs and harvest equipment available.

Road Drainage Practices

Road Cross-Sections

The most commonly used road cross-section designs are crowned, insloped and outsloped (Figure 6).

- **Crowned roads** may be used in all terrains. Water turnouts and cross-drains must be provided (Figure 7).
- **Insloped roads** may be used on sharp, steep turns as a safety precaution.
- **Outsloped roads** may be built in moderately sloping terrain, such as roads on upper parts of long slopes. Outsloped roads are not suitable for deeply cut side-hill roads or in locations where upslope drainage areas are large.

Cross-Drain Culverts

Spacing

Cross drains are used to carry water from upslope ditches on mid-slope and insloped roads under the road, where it can be safely released on the downslope side of the road. To minimize ditch erosion, prevent washouts and scouring of hillslopes below the outlet, space cross-drains more closely on steeper slopes (Table 2). Culvert spacing can be determined by the following formula:

Spacing (in feet) = (400) / (Slope %) + 100.
Express the slope percent as a whole number (for example, 15% = 15).

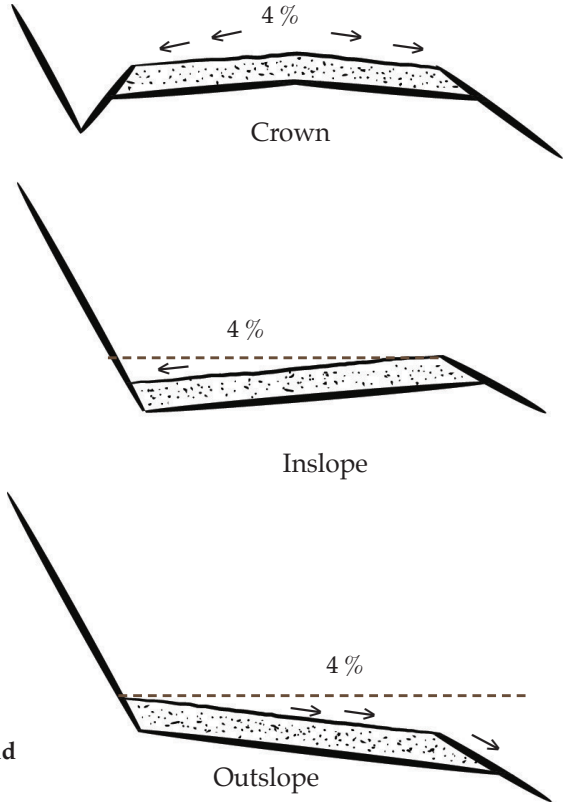

Figure 6. Typical Forest Road Cross-sections.

Figure 7. Crowned Road with Ditches.

Table 2. Spacing Guidelines for Cross-Drain Culverts (figures are based on the formula above).

Road Grade (%)	*Distance Between Culverts (feet)*
1	500
2	300
4	200
6	167
8	150
10	140

Culvert Size

Select culvert size according to the road area and upslope area drained by the ditch. If cross drains are installed at the proper spacing, they will likely drain no more than 2 acres — 4 acres at the most. Therefore, an 18-inch diameter culvert is adequate (Table 6, page 24). If the drainage area is greater than 4 acres, the road likely crosses an ephemeral drain. In such a case, treat the cross drain as a stream crossing and turn drainage away before reaching the stream where practical. To avoid clogging, do not use culverts smaller than eighteen (18) inches in diameter.

Culvert Installation

- Fill over the culvert should be at least one-half the diameter of the pipe (Figure 8). Never use less than one foot of fill.
- Plug the ditch immediately downhill of the culvert inlet to direct all water into the culvert (Figure 9). Armor the ditch plug with rock to prevent washout.

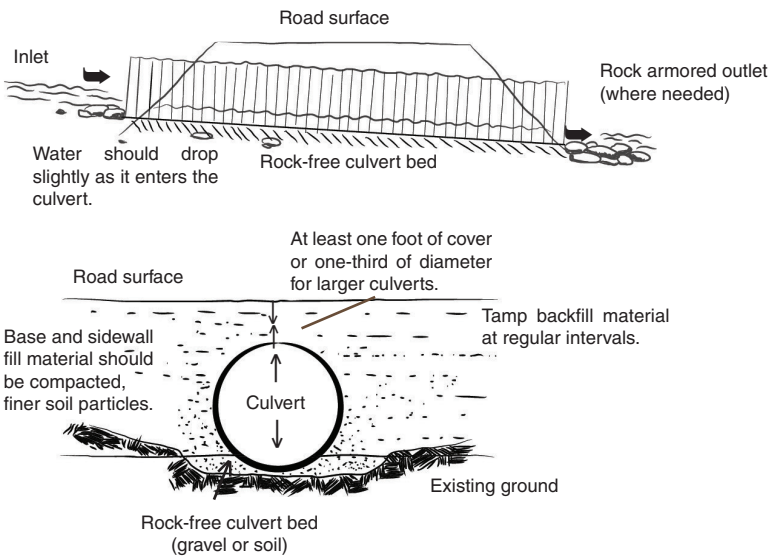

Figure 8. Proper Culvert Design.

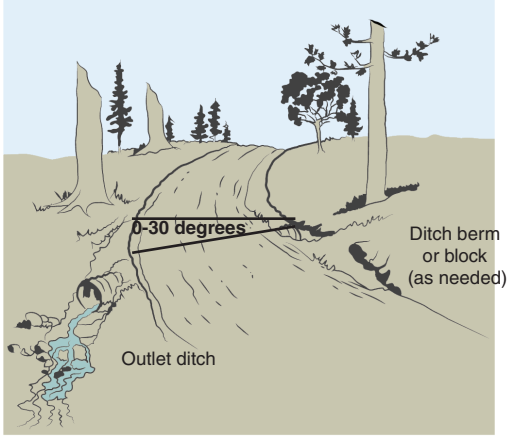

Figure 9. Properly Installed Cross-drain Culvert with Ditch Plug.

Figure 10. Cross-drain Culvert with Armored Outlet.

- Extend the culvert outlet beyond the fill slope. Install rocks or logging slash at the outlet to prevent erosion by concentrated flow (Figure 10).
- Angle the culvert 30 degrees down slope.
- Make culvert gradients at least two percent greater than the ditch gradient.
- Locate cross-drain culverts so they do not outlet directly into streams.

Drainage Dips

Dips in the roadway provide cross drainage and drainage of water that collects on road surfaces. Dips can be used instead of cross-drain culverts, usually at lower cost. They are especially well suited for temporary roads still being used and have a road profile and drainage systems in place. Dips must be deep enough to provide adequate drainage, but wide enough to allow the safe passage of trucks and equipment. The type of dip used, whether a rolling dip or broad-based dip, depends on expected use and the type of road. Determine the spacing of drainage dips by slope steepness and local conditions. Place rock or logging slash below the outlet to prevent erosion.

- **Rolling dips** are best for spur and temporary roads with little traffic and where average vehicle speeds are low. Rolling dips resemble "stretched out" water bars. Excavate the dip out of the existing road grade (Figures 11 and 12). Space dips according to the grade (Table 3).

Table 3. Spacing Guidelines for Rolling Dips.

Road Grade (%)	*Dip Spacing (feet)*
2-5	180
5-10	150
10-15	135
15+	120

Broad-based dips (Figure 13) are best for roads with high traffic volumes and speeds, such as permanent main haul roads. The road grade between dips is adjusted, so there is a constant grade from the crest of the berm of one dip to the bottom of the next dip down slope. Use the spacing guidelines in Table 4.

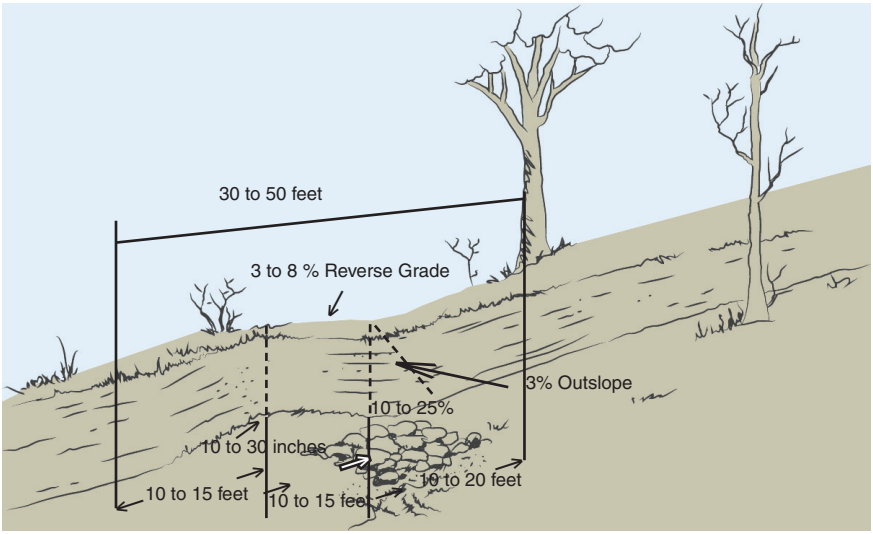

Figure 11. Diagram of a Rolling Dip.

Figure 12. Example of a Rolling Dip.

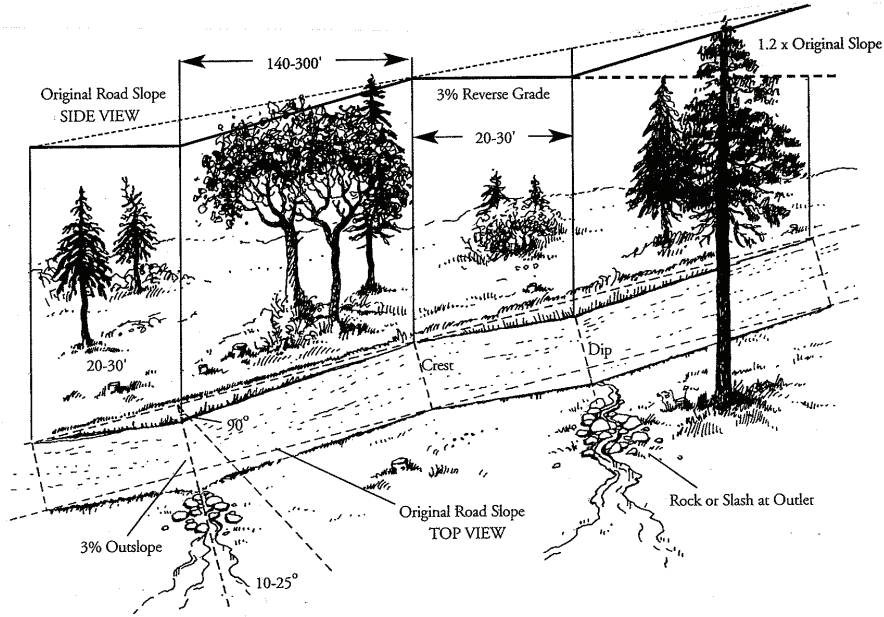

Figure 13. Diagram of a Broad-based Dip.

Table 4. Spacing Guidelines for Broad-Based Dips.

Road Grade (%)	*Distance Between Dips (feet)*
2	300
4	200
6	165
8	150
10	140
12	130

Turnouts or Wing Ditches

Turnouts (Figure 14) provide drainage of ditch water from roads on ridges, points of ridges and gentle side slopes. On flat roads, turnouts provide surface drainage and help the road dry out.

Turnout Installation

- On sloping roads, use the spacing guidelines in Table 5.
- Intersect the ditch line at the same depth and out slope one to three percent.
- Turn at a 30-degree to 40-degree downslope angle (with respect to the roadbed).

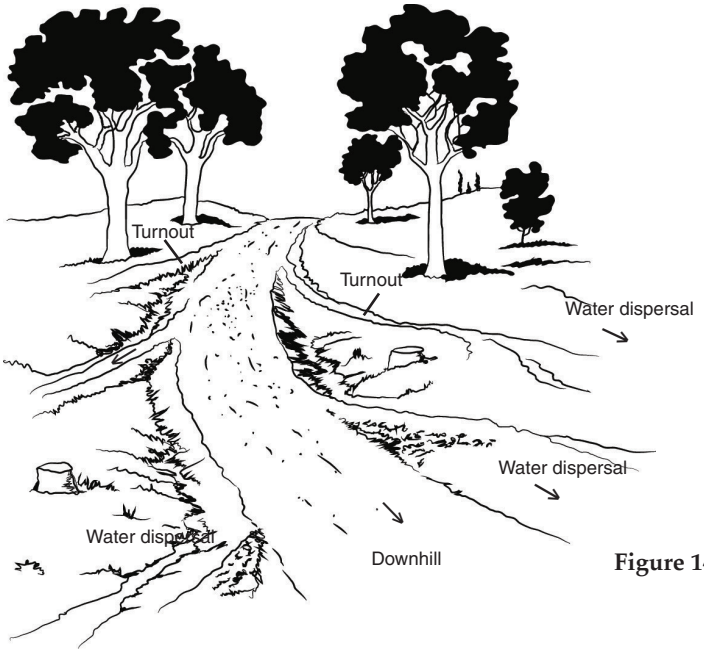

Figure 14. Turnouts.

- Place rock and logging slash at the outlet where needed to prevent erosion.
- Direct turnout outlets onto the forest floor, not into stream channels.

Table 5. Spacing Guidelines for Turnouts.

Road Grade (%)	*Distance Between Turnouts (feet)*
2-5	200
5-10	100
10+	75

Temporary Roads

Temporary roads are access routes needed only for a short period, to transport forest products or machinery and equipment in support of other silvicultural activities. Poorly designed and located temporary roads can erode and become contributors of non-point sources pollution.

Where timber harvesting occurs infrequently and future access for silviculture, recreation and fire control is not needed, temporary roads may be used. Temporary roads are used during the planned activity and are promptly closed and stabilized. They may be suitable for landowners who are away from their property for extended periods and cannot perform the frequent maintenance required on permanent roads. Use temporary haul roads in conjunction with permanent road systems to reduce harvest skid distances.

Planning

- Use soil surveys, topographic maps, aerial photos and other resources to achieve the most practical road location.
- Design the smallest amount of road needed to achieve management objectives.
- Locate roads outside of SMZs except where necessary at stream crossings.
- Minimize the time from construction to closure to reduce exposure.
- Close and stabilize all temporary roads upon completion of management activity.

Construction

- Reduce disturbed area by minimizing road width needed to meet management objectives.
- Consider broad-based dips or rolling dips on slopes greater than 6 percent to 8 percent, but less than 15 percent.
- Minimize changes to the area's natural drainage patterns to avoid directing large volumes of high velocity water onto disturbed soil.
- Minimize stream crossings.

Mulching and Seeding

On most sites, exposed soils quickly revegetate following disturbance. Root sprouts and germination of native seeds often cover bare areas rapidly. In some situations, application of grass seed or mulch will prevent soil erosion and help disturbed sites recover more quickly. Examples include landings, road cuts and fill and steep slopes where cover is inadequate. Mulch retains soil moisture, which is important for seed germination, and protects the soil from erosion. Mulch can be used to promote natural revegetation or protect seeds and fertilizers that have been spread over an area. If seeding or mulching is needed, follow these guidelines:

- Seed mixtures should include quick-germinating and fast-growing species for rapid soil protection, plus perennial species for longer protection until native vegetation returns to the site. Because of risks associated with the introduction of non-native species, consult with local conservation agencies, such as the NRCS or Conservation District, for species, seeding and fertilization recommendations.
- Timing of seeding is critical to ensure successful revegetation. Consult a natural resource professional when needed.
- Seeding may not be necessary on flat areas because of seed already in place.
- Incorporating the seed into the soil will enable it to remain in place without mulch or netting.
- If seed and fertilizers are broadcast, especially on slopes, use mulch to prevent washing prior to germination and rooting.
- On steep slopes, mulch with 4,000 pounds of straw per acre, or consider using netting, fabric or other material that will protect the soil from erosion.
- On extremely steep slopes, or on areas where water flow concentrates, netting may be necessary to hold mulch in place.

Stream Crossings

Crossing streams during logging operations presents special problems and range in complexity. Equipment operating in or near stream channels may add sediment directly to streams. Crossings that are poorly located or constructed may destabilize streambanks and cause channel erosion. The following guidelines are intended to help loggers and landowners deal with stream crossings of a minor nature. Where logging operations require the construction or repair of crossings on major streams, in more complex situations or cases where a permit may be required, consult a qualified forestry consultant or the State's Water Quality Forester.

Types of Crossings

Types of stream crossings ordinarily used during and after logging include culverts, concrete slabs, rocked fords, log or timber bridges and natural fords.

Culverts—Use properly sized and installed culverts (Table 6 and Figure 8). Do not obtain fill material from within the stream channel!

Concrete Slabs—Depending on the soil, streambank and channel conditions, satisfactory crossings can be made with low-water concrete slabs. Concrete slabs are suitable for high-use permanent roads.

Rocked Fords—Improved rocked fords (Figure 15) may be suitable for temporary, as well as permanent roads, depending on use and local conditions.

Bridges—Bridges vary in expense and design, depending on the stream channel conditions, expected use and whether or not a road is temporary or permanent. "Portable" bridges work well on temporary roads crossing small

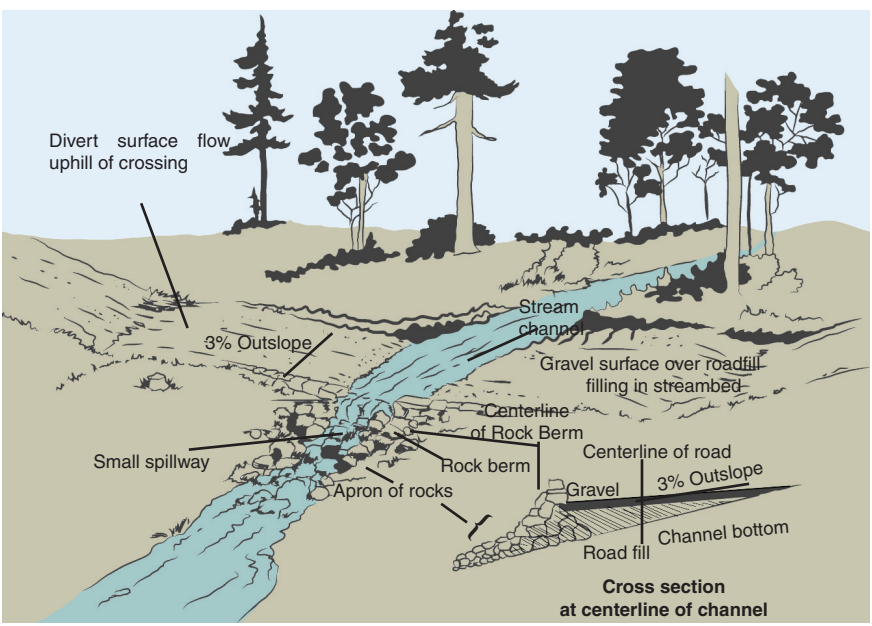

Figure 15. Typical rocked ford.

Table 6. Culvert Size Chart.

Drainage Area Above Pipe (acres)	*Single Pipe Diameter (inches)*	*Pipe Equivalency Data (pipe diameters in inches)*
2-5	18	15,15
10	24	15,18 or 15,15,15
20	27	18,24 or 18,18,18
30	30	18,24 or 18,18,18
40-50	36	24,30 or 18,24,24
75	42	30,30 or 24,24,30
100	48	36,36 or 30,30,30
150	54	36,42 or 30,36,36
More than 150	Consult a professional	

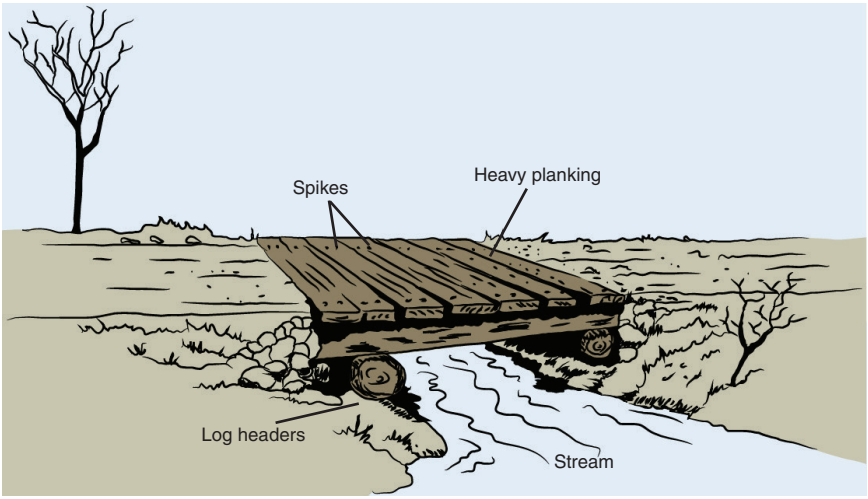

Figure 16. Timber Bridge.

streams. Inexpensive log or timber bridges (Figure 16) may be suitable for temporary or permanent roads. Portable bridge mats are suitable for temporary stream crossings (See Bridge Mats, page 26).

Natural Fords—Unimproved natural fords (Figure 17) provide a low-cost and low-impact alternative for temporary stream or channel crossings on dry sites with stable soils or rocky bottoms, and minor hillside channels.

Stream Crossing Guidelines

- Use cross-drains and turnouts to divert water from road surfaces and ditches before reaching stream crossings (Figure 18).
- Minimize stream crossings by good road planning. Follow the forest management plan.

Figure 17. Natural Rocked Ford.

- Cross streams at right angles whenever possible.
- Use bridges or culverts where a ford or crossing cannot be found to minimize rutting or siltation.
- Construct low-water bridge fills and overflow culverts so no more than minimal changes in natural streambeds during high water periods is caused.
- Low-water bridge fills and earth embankments constructed for use as bridge approaches should be protected from erosion by high water. Methods of protection may include use of rock fill or riprap, planted or seeded ground cover, concrete surfacing and retaining walls or bulkheads.
- If slash or debris from road operations is deposited in a stream channel, it should be removed prior to removal of equipment from the area.
- Bridges should not constrict clearly defined stream channels. Permanent bridges should be designed to pass the normal flood level, or the road approach should be constructed to provide erosion protection from overflow floodwaters that exceed the water-carrying capacity of the drainage structure.
- When crossing wetland areas or other jurisdictional waters of the U.S., follow the mandatory forest road BMPs described in Part 9 Wetlands (page 46).
- Culverts that drain fish-bearing (large intermittent and perennial) streams should be installed on grade to avoid disruption of flow and not block fish passage.
- When crossing broad channels, several small culverts, spaced throughout the crossing, may be preferable to a single large one. This arrangement maintains a lower road surface elevation and does not artificially concentrate the flow into one small segment of the channel.

Figure 18. Turnouts.

- Natural, low-water fords may be used where streambanks and stream bottoms are stable, and turbidity is minimized. Lining these crossings with logs or slash will further minimize soil disturbance. Promptly remove all added material from the channel crossing when logging is completed.
- Stabilize approaches to fords, bridges and culvert crossings to reduce sediment in the stream by placing aggregate or other suitable material on the roadbed.
- Stabilize all permanent crossings. Restore and stabilize all temporary crossings.
- When constructing a ford, material should not significantly impound stream flow, impede fish passage or cause erosive currents.

Select culvert size according to the area drained by the ditch (Table 6). To avoid clogging, do not use culverts smaller than 18 inches in diameter. In some instances, several smaller culverts may be preferable to a single larger one.

Bridge Mats

Consider using timber bridge mats (Figure 19) to span narrow drainages and avoid skidding or hauling through stream channels. When setting bridge mats in place, keep equipment out of the channel. Place the mat across the channel first, and then adjust them to ensure a firm, stable crossing.

- Place mat panels tightly together. Avoid leaving gaps, to prevent sediment and debris falling into the stream or channel.
- Leave "bumper trees" on each side of the mat and each side of the crossing so dragged logs travel straight across the bridge mat to minimize debris swept into the stream.

Figure 19. Portable Bridge Mats.

- Occasionally inspect the mats while in use, and clean off excess mud, soil or debris to prevent its entry into the channel.
- Readjust mat panels if slippage occurs.
- Remove the mats carefully to minimize damage to the streambanks and channels, preferably by lifting rather than by dragging.
- Use water diversions such as turnouts or water bars to control runoff and prevent channelized flow into streams at crossing locations.

Road Maintenance

Proper maintenance of permanent access roads is of vital importance to logging and land management activities. A properly functioning drainage system is essential. Use the following guidelines to maintain roads and reduce erosion.

Road Maintenance Guidelines

- Revegetate or stabilize erodible areas where natural vegetation is not sufficient to stabilize the soil.
- Regularly inspect ditches, culverts, turnouts, dips and water bars for blockage and promptly restore to working condition.
- Limit road use during wet seasons.
- Grade road surfaces only when necessary to eliminate rutting and surface erosion channels and to re-establish the appropriate drainage cross-section (Figure 6). Grading loosens road surface materials, temporarily increasing erosion.
- Maximize sunlight exposure to the road surface to encourage drying.

Figure 20. Example of Road Closure.

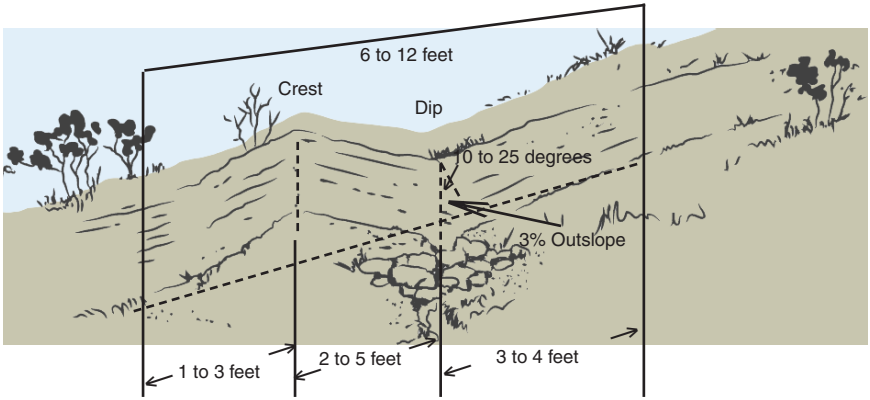

Figure 21. Water bars.

- Keep the road reasonably free of ruts, side-cast berms and debris, which prevents water from flowing freely off road surfaces into drainage structures.
- Maintain the intersections with public roads to prevent mud and debris from being carried onto these roads.
- Allow ditches to revegetate as much as is practicable.
- Close or restrict traffic on roads whenever possible. This will allow roads to stabilize and revegetate.
- If applying herbicides for brush control, follow label directions and applicable State and Federal laws in storage, transportation, handling and application. Avoid application of herbicides directly to water bodies. See Part 6 Forest Chemicals.

Road Closure

Temporary or permanent roads no longer needed should be closed and stabilized according to the following guidelines.

Road Closure Guidelines

- Promptly close all temporary roads and skid trails after harvesting or other silvicultural activities are completed (Figure 20).
- Consider temporary measures if moving from the site prior to completion.
- Close access points with a large ditch or berm to prevent all vehicular traffic.
- Water bars or other erosion control devices at the appropriate spacing are needed to properly stabilize the road (see Table 7 for spacing guidelines).
- Stabilize stream crossings appropriately to minimize risk of future erosion.
- Remove all temporary crossings, such as culverts, temporary bridges, logs or any other debris from the stream channel.
- Remove sediment and debris from dips, ditches, turnouts and culverts.
- Spread logging slash and mulch on bare areas.
- Smooth and shape road surfaces to prevent channelized water flow.
- Consider site preparation and reforestation to further stabilize temporary roads.
- Seed or revegetate if necessary to cover highly disturbed areas.
- Periodically inspect retired roads to assure stabilization techniques are still effective and permanent crossings are clear and operating properly.

Water Bars

Water bars (Figure 21) provide needed removal of surface water on inactive or closed roads by diverting runoff into roadside vegetation or onto the forest floor and to reduce water volume and velocity. Water bars are not designed to withstand vehicular traffic, and repeated use will rapidly decrease the effectiveness of these drainage structures.

- Place water bars at an angle of 30 to 45 degrees to the road.
- Provide a cross-drainage grade of about three percent to facilitate drainage.
- Place rock or logging slash below the outlet.
- Construct water bars to restrict vehicular traffic. As a rule of thumb, construct water bars 24 to 30 inches in height. If unrestricted traffic is likely to be a problem, use water bars that are 3 feet in height.

- Water bars should have open drains into the dispersion area (forest floor).
- Space water bars more closely on steeper slopes, as shown in Table 7.

Table 7. Spacing Guidelines for Water Bars.

Road Grade (%)	*Distance Between Water Bars (feet)*
2	250
5	135
10	80
15	60
20	45
30	35

Specifications for water bar construction on forest roads, trails and firebreaks must be site specific and should be adjusted to existing soil and slope conditions.

- **Avoid wetlands and stream crossings where possible.**
- **Avoid construction operations during wet soil conditions.**
- **Avoid logging during wet periods.**
- **Avoid steep slopes and unstable soils.**
- **Avoid wet, flowing fords where possible.**
- **Avoid application of herbicides directly to water bodies. See Part 6 Forest Chemicals.**

Part 4. Timber Harvesting

Introduction

Timber harvesting is an essential component of most forest management and improvement efforts. Guidelines to help reduce the potential for non-point source pollution resulting from harvesting trees are as follows:

Landings

During Harvest

- Landing size and spacing should consider access, topography, efficiency and safety.
- Locate landings on well-drained, gently sloping ground. Location should take advantage of topography to minimize accumulation of water on the landing and to permit diversion of water onto the forest floor.
- Locate landings to minimize adverse impact of skidding on the natural water drainage pattern.
- Locate landings outside of SMZs and away from stream channels.
- Slope the landing gently (1 percent to 2 percent grade) to allow for drainage, where needed.
- Divert runoff from access roads and skid trails so water does not pool on the landing.
- Spills are federally reportable if they produce a sheen or cause a discoloration of the surface of the water on waters of the U.S. Spills of more than 20 gallons or causing a sheen on the water must be reported to the State Department of Environmental Quality (see clean-up and reporting procedures in Part 8).

After Harvest

- Install a shallow ditch above the landing to divert run-off where needed.
- When skidding and hauling is complete, grade out any ruts to form a smooth surface and restore the intersection with the road, as well as to drain impounded water on or around the landing.
- Cover bare soil with logging slash.
- Mulch and seed bare soil where necessary.
- Clean up, remove and properly dispose of all litter, equipment maintenance fluids and other debris remaining from the logging operation.

Felling and Bucking

- Careful felling can improve environmental performance by protecting residual trees and reproduction and by minimizing the number of trees felled into streams.
- Trees should not be felled into streams except for those trees that cannot otherwise be practically and safely felled outside the stream. Such trees or treetops should be removed promptly.
- Directional felling should be practiced near perennial streams to minimize debris entering the stream, facilitate disposal of logging debris and reduce damage to residual trees in partial cuts.
- Fell trees parallel to the skidding direction and with butts toward the landing to the extent feasible to facilitate skidding and minimize soil disturbance.

Skidding and Skid Trails

During skidding operations, the primary objective is to minimize soil disturbance and compaction.

- Include skid trail layout as part of the logging plan. Their design should facilitate movement of harvested trees from the stump to the log deck efficiently, while minimizing damage to residual trees and reducing soil erosion and sedimentation.
- Use aerial photos, topographic maps and other resources when designing or planning the location of skid trails.
- Where feasible, skid upslope, but not straight up and down. Skid in a slant or zigzag pattern to break the grade and avoid long, steep grades.
- Minimize skidding on steep grades, except where necessary to avoid boundary lines, sensitive areas or other areas not accessible by roads of lesser grade. If steep grades are necessary, use practices (water bars, logging slash) that will prevent concentrated water flows, causing gullying.
- Locate skid trails outside the SMZ.
- Stream channels should not be used for skid trails.
- Minimize or avoid crossing streams to reduce the number of crossings.
- All crossings should be at a right angle to the stream.
- Use a temporary timber bridge mat if stable crossings are not available on narrow channels. Any temporary measures used to cross a stream should be removed and the crossing restored when logging is complete.
- Upon completion of skidding operations, immediately protect areas subject to erosion using water bars and water turnouts where necessary. Water bars and turnouts should be installed according to the spacing guidelines in Table 8.
- Install water bars at a 30-degree to 45-degree angle downslope with the downslope ends open to prevent water accumulation. Scatter logging slash or mulch material to cover the trail and supplement water bars (Figure 22).

Figure 22. Scattering Logging Slash or Other Mulch Material on Skid Trail.

Table 8. Recommended Spacing between Water Bars and Turnouts on Skid Trails.

Average Slope (%)	*Distance Between Water Bars (feet)*
2	250
5	135
10	80
15	60
20	45
30	35

Special Considerations for Timber Salvage Following Natural Disasters

When natural disasters, such as wildfires, ice storms and tornadoes affect a forest stand, timely timber salvage is necessary. It is important not to compromise the forestry BMPs during this process:

- Make sure the ground is stable enough to support the use of heavy equipment to avoid rutting, and minimize equipment operations in SMZs to reduce exposure of bare soil.
- Reestablish SMZ boundaries to ensure stream protection.

- Keep roads, skid trails and landings out of SMZs.
- Protect and leave trees in the SMZ that were not severely damaged and to maintain residual basal area.
- Remove downed trees and tops from streams unless greater damage to streambanks and streambeds will occur by removing them.
- Use dispersed skidding methods to retrieve trees in the SMZ.
- Follow normal BMPs on the rest of the tract and use common sense.
- When restoring SMZ functions, avoid heavy site preparation and machine planting. Protect stump sprouts and natural regeneration to reestablish the SMZ. If tree planting is necessary, favor native hardwood species and plant by hand.

- **Avoid concentration of runoff (channelized flow) down slope from the landing.**
- **Avoid logging excessively wet soils that could create deep ruts or liquid soil. Minimize rutting where the potential for affecting water quality through increased sedimentation is present. Avoid creating ruts that run up and down the slope and have the potential of forming channelized flow.**

Part 5. Site Preparation

Introduction

Site preparation may include one or a combination of mechanical treatments, chemical applications or prescribed burning. The techniques used will depend on soils, slope, site condition, vegetation, costs and regeneration objectives. While site preparation is generally considered a *normal silviculture* activity in jurisdictional wetlands, EPA and the Corps have defined requirements for mechanical site preparation work in wetlands when the purpose is to regenerate pine species (see Part 9 Wetlands).

Mechanical Site Preparation

Carefully apply these practices when working near streams, lakes or other water bodies. Mechanical site preparation can include shearing, spot cultivation, raking, ripping (subsoiling) (Figure 23), chopping, windrowing, piling, bedding, combination plow and other methods where equipment is used to move logging debris or improve soil conditions. The following are recommended practices for mechanical site preparation:

- Use contractors who have demonstrated knowledge of forestry BMPs.
- Select the site preparation technique to efficiently and effectively help to establish seedlings, control competing vegetation and minimizing potential soil loss (Table 9).
- On slopes of 5 percent or less, any site preparation treatment may be considered.
- On slopes of 6 percent to 10 percent, intensive mechanical methods, other than chopping, should follow slope contours. Drum chopping should be done perpendicular to the slope contour. On erodible soil types (e.g., sand, sandy loam), intensive treatments must be carefully planned and monitored.
- On slopes of 11 percent to 20 percent, mechanical methods, other than chopping should follow slope contours. Avoid high-intensity treatments, such as bedding.
- On slopes greater than 20 percent, use only low-intensity mechanical methods following slope contours.
- Minimize the soil displaced into windrows.
- Arrange windrows along the contour to minimize erosion.
- Leave occasional breaks in windrows to facilitate surface drainage.

Bedding/Three-in-One Plowing

Bedding or three-in-one plowing are intensive silvicultural practices used to enhance root development and increase seedling survival. These practices expose mineral soil and have greater potential to increase erosion better than other meth-

Table 9. Recommended Site Preparation Practices by Slope Characteristics.

Silvicultural Practice and Intensity	*Slope Characteristics*			
	0-5%	*6-10%*	*11-20%*	*>20%*
Low Intensity (contour ripping, chopping)	OK	OK	OK	OK
Moderate Intensity (shearing, spot cultivation, machine planting, shear-and-bed, shear with 3-in-1 plowing)	OK	OK	Avoid on sandy, erodible soils	Not recommended
High Intensity (shear and pile, bedding, raking, clear and windrow)	OK Stay on contour	OK Stay on contour	Not recommended	Not recommended

Figure 23. Ripping on Contour.

ods of mechanical site preparation. When bedding or three-in-one plowing, consider the following:

- Use contractors who have demonstrated knowledge of the forestry BMPs.
- Orient beds to facilitate natural drainage and avoid impounding water.
- When bedding on slopes greater than 3 percent, beds should follow slope contours where feasible.
- Plan water outlets to release water and minimize the movement of soil.
- Do not bed in SMZs, sloughs or wet depressions, or across ephemeral drains.

- To facilitate natural drainage within bedded areas on slopes, and/or where soil textures and drainage classes are prone to slow infiltration rates, periodically lift the bedding plow to create short nonbedded breaks. When determining the length of these breaks and the distance between breaks, consider slope position, slope percent and soil type. Also, refer to Part 9 Wetland BMPs.
- Use banded herbicide applications (treated strips) instead of a broadcast application where erosion is a concern.

Chemical Site Preparation

Herbicide treatments are acceptable site preparation methods on all slopes, if conducted properly. When used properly, chances of off-site impacts are minimal. Also refer to Part 6 Forest Chemicals for additional guidelines.

- Follow label directions and applicable State and Federal laws in the storage, transportation, handling and application of all forest chemicals.
- The forest manager and applicator should discuss and clearly understand:
  - The boundaries of the area to be sprayed.
  - The characteristics of the product being applied (drift, soil movement, volatilization, etc.).
  - Sensitive areas to be avoided (SMZs, hardwood retention areas, food plots).
- Carefully check wind and temperature conditions to minimize the chance of off-site application.
- Identify and protect SMZs and other sensitive areas, particularly if aerial applications are used.
- On environmentally sensitive sites (e.g., adjacent to agricultural crops), consider using ground-application methods instead of aerial applications.
- Store and mix chemicals where there is little threat of spills entering drains, ditches or waterways.
- Clean and dispose of chemical containers according to instructions found on the label.

Prescribed Burning

Prescribed fire can be used alone or in conjunction with chemical and/or mechanical site preparation. Prescribed burning only slightly increases the chance for soil erosion if conducted properly. The following are recommended practices for prescribed burning:

- Comply with State smoke management guidelines and burning notification requirements.
- Have firefighting equipment readily available.
- Plow firelines only where necessary, making use of existing barriers such as roads, water bodies, etc.
- Install firelines on the contour as much as possible.
- Use bladed or harrowed firelines instead of plowed firebreaks where possible.
- Install water bars with water turnouts in firelines at the same intervals as recommended for forest roads (Table 8).
- Do not plow firelines that channel surface runoff into streams, roads or gullies.
- Back drag with a bulldozer blade or use hand tools when it is necessary to tie firelines into stream channels.

- A low intensity (backing) fire through the SMZ is often preferable to firelines surrounding the SMZ. Carefully compare the benefits of not constructing firelines along the SMZ with the possibility of damaging trees in the SMZ.
- Also, refer to Part 7 Fire Management.

- **Avoid discharging water from bedded sites directly into road ditches, ephemeral drains or SMZs.**
- **Avoid running beds into other beds at right angles when possible.**
- **Avoid damage to ditches, water bars or other water control structures and keep equipment out of seeded areas and other special areas of concern or sensitivity.**

Part 6. Application of Forest Chemicals (Pesticides and Fertilizers)

Introduction

Chemicals perform important functions in forest management, and generally fall into two broad categories – pesticides and fertilizers. Avoid applying these chemicals to water bodies and SMZs unless they are registered for aquatic use.

Pesticides: Forest pesticides include a wide variety of chemicals that fall into one of the following five categories:

- **Insecticides** – to control unwanted and damaging forest insects.
- **Herbicides** - to control unwanted woody and/or herbaceous vegetation.
- **Rodenticides**-to control damaging rodent populations (e.g., gophers and moles).
- **Fungicides** - to control damaging fungi or fungal spores.
- **Nematocides** - to control nematodes as seeding rates, timing and fertilization needs (if any).

Fertilizers: The applications of nitrogen, phosphorus and other elemental fertilizers may be used to increase the growth of established forests on nutrient-limited sites.

Apply chemicals only in accordance with the manufacturer's label instructions and applicable federal and state regulations relating to their sale, transportation and use to ensure that public health, water supplies and aquatic habitat are protected from contamination. Although not a water-quality BMP, accurate recordkeeping as may be required by law, regulation or label can help reduce the potential risks to water quality.

Avoid Contact with Forest Soils

- Use protective materials, such as matting or basins, to catch spills and leaks from containers.
- Designate pesticide tank and fertilizer hopper filling areas. Locate and keep these areas on level terrain, a minimum of 100 feet from all streams, ponds and lakes.
- Always store pesticides and fertilizers in properly labeled and approved containers.

Store Excess Chemicals Off-Site Where Possible

- When feasible, bring only one day's worth of material to the field. Careful application calculations should be made to mix only the amount of pesticide/fertilizer necessary for each job.

- Apply all material on site to reduce the risk of accidental spilling when changing application sites.
- Excess pesticides and fertilizers should **always** be disposed of in a manner consistent with the product label.
- Excess pesticides and fertilizers should be secured in a dry location until used, recycled or disposed of properly.

Pesticide Containers

- As a rule of thumb, triple rinse each empty pesticide container with water. Capture all rinse water, return it to the sprayer and apply it to the application site.
- Collect and store all empty containers until they can be transported off-site for recycling or disposal at an approved site in a manner conforming to state regulations and label directions.

Application Technology

- When considering large-scale ground application by skidder and/or tractor-mounted sprayers and aerial spraying (Figure 24), avoid direct application to water, SMZs and other sensitive areas by using contractors with Global Positioning System (GPS) capabilities. GPS tracking capabilities allow extremely accurate application, and most systems are capable of printing a map or aerial photograph of the treatment area with actual application lines and data for recordkeeping purposes.

Follow All EPA Label Instructions

- Calibrate application equipment to apply materials uniformly and in the correct quantities.
- Apply chemicals and fertilizers only with favorable weather conditions.
- Exercise special care during application to prevent drift.

Figure 24. Chemical Application.

- Identify and avoid SMZs and surface water to prevent fertilizers and chemicals not specifically labeled for aquatic use from drifting over open water, or from accidentally being applied directly on the water. *EPA's Proposed General Permit for pesticide applications into, over or near water went into effect on October 31, 2011. In 2012, the EPA approved the State of Oklahoma's request for the Department of Agriculture, Food and Forestry to administer the Agriculture National Pollution Discharge Elimination System (Ag NPDES) permit program. Applicators and those who authorize pesticide applications must become familiar with the application thresholds and permit requirements.*
- When water is used in mixing, provide an air gap or reservoir between the water source and the mixing tank.
- Use uncontaminated pumps, hoses and screens.
- Mix chemicals only where possible spills would not enter a stream, lake or pond.
- Maintain equipment to prevent any significant leakage of chemicals during transportation, storage, mixing or application.

Cleanup

- After application, clean tanks and equipment according to label directions.
- Conduct cleanup operations in a location where chemicals will not enter any stream, lake or pond.
- Cleanup residues should not be permitted to collect in hazardous concentrations, and disposal should be in conformity with state requirements.

Target Applications on the Desired Site

- When applying chemicals not labeled for aquatic use in SMZs or adjacent to open water, use spot-injection or stump treatment methods.
- Only pesticides specifically labeled "for aquatic use" may be applied directly to water.

Spills

- Ensure all employees are trained on proper spill containment and cleanup.
- Maintain an approved spill-containment and cleanup kit appropriate for all pesticides and fertilizers being used. If a spill should occur, follow the directions and in the order as presented:
  1. Identify the spilled product.
  2. Protect yourself and others. Wear protective clothing and equipment appropriate for the spilled materials. Avoid coming in contact with any drift or fumes that may be released.
  3. If possible, stop the leaking container/sprayer.
  4. If possible, contain the spill and keep it from spreading. Shovel a dike around the spill. Use absorbent material, such as sawdust or loose soil, to soak up the pesticide. Place a bucket under a leaking sprayer. Keep the spill from flowing into any water (ditches, puddles, ponds, lakes and streams).
  5. In some cases, a Reportable Quantity (RQ) of spilled pesticide is more than 10 gallons liquid or 25 pounds dry weight of pesticide concentrate or 50 gallons of an application mixture. However, the RQ depends upon the active ingredient of the product, so refer to the label or seek assistance from DEQ as shown below.

6. Spills of this size or greater shall be reported by telephone within 24 hours and by written notice within three (3) days, as follows:

A federally reportable quantity of spilled material is any amount that creates a sheen on the waters of the United States or which creates a discoloration of the surface of the water. Report spills to EPA's National Response Center at 1-800-424-8802. Additional guidance is available from the following website: http://www2.epa.gov/emergency-response/reporting-requirements-oil-spills-and-hazardous-substance-releases. Spills which create a sheen on the water or which exceed 20 gallons must be reported to the State Department of Environmental Quality at 1-800-522-0206. Also refer to the DEQ website http://www.deq.state.ok.us/factsheets/land/Dieselspill.pdf.

Comply with State and Federal Law

- The use of pesticides in Oklahoma is governed by the Pesticide Applicators Law. The law states that any person who applies pesticides commercially must be certified to do so, and any company (including one-person operations) must be licensed for the type of work being done.
- Non-commercial operations, including government agencies, must be licensed and their applicators must be certified to legally use restricted-use pesticides.

Restricted Use Pesticides

- Pesticides labeled as "Restricted Use" can only be applied by trained, licensed individuals or under their direct control.
- Individuals applying non-restricted pesticides should consider obtaining a private applicators license. Obtaining an applicators license provides some learning opportunities.
- Applicator licensing is available through the Oklahoma Department of Agriculture, Food, & Forestry's Consumer Protection Services Division, 2800 North Lincoln Boulevard, Oklahoma City, OK 73105; (405) 521-3864. http://www.oda.state.ok.us/cps.htm

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Part 7. Fire Managment

Introduction

Firelines are an important practice in silviculture and wildfire protection activities. Precautions should be taken to avoid creating a source of sediment, particularly on slopes in erodible soils. Using natural firebreaks, such as roads, rocky or wet drainages or other features that limit the spread of fire naturally will minimize the amount of necessary fireline construction. Some firelines come directly down slope from ridge to drainage, creating an ideal channel for water movement and soil erosion similar to a drainage ditch along a road. Best management practices will prevent channelized flow, improve drainage, slow runoff, improve water infiltration and stabilize bare soil.

Timing

- On firelines constructed for planned prescribed burning or routine fire protection activities, install drainage control practices immediately.
- During wildfire suppression, immediate waterbarring may not be possible. In these cases, install drainage practices as soon after the fire is controlled as practicable, even if this requires a return visit.

Minimize Soil Exposure

- Reduce soil disturbance by constructing firelines only to the minimum width and depth necessary for the intended purpose.
- Minimize disruption of large rocks and tree root masses.
- Where feasible, minimize fireline construction by tying lines into existing features that prohibit fire spread.

Install Drainage Practices

- Construct water bars on firelines that are similar to those for roads, but on a smaller scale.
- Water bar spacing will depend primarily on slope, and again will be similar to the recommendations for roads and skid trails, shown in Table 8.
- In some cases, constructing rock check dams by hand may be a satisfactory and less costly alternative to constructing water bars with heavy equipment.

Revegetate Promptly

- Bare areas will generally revegetate naturally in a short period. On steeper slopes, or where a green strip is desired for wildfire protection, seed bare areas with native grass species. Consult local conservation agencies for recommended species, seeding rates and timing.

Part 8. Equipment Operation, maintenance and Cleanup

Introduction

A variety of other materials are brought into forests that have a potential for water quality impacts:

- **Fuel** – Diesel fuel and gasoline for equipment operations.
- **Lubricants** – Hydraulic fluids, grease and oil to maintain equipment.
- **Chemicals** – Solvents, paints and cleaning fluids.
- **Containers** – Boxes, cans, bottles and other materials .

If any of these materials are mishandled or spilled or are left in the woods, they can be washed directly into streams or contaminate forest soil. To reduce the possibility of soil and water contamination, follow these guidelines:

Avoid Contact with Forest Soils

- Use protective materials, such as matting or basins, to catch spills and leaks from fuel containers.
- Designate specific refueling areas and keep protective materials nearby, rather than scattered throughout the work site. Locate these areas on level terrain, a minimum of 100 feet from all streams, ponds and lakes.
- To deter spills, do not store excess fuel on-site. Only bring one day's worth of fuel to the work site where feasible.
- Collect all waste lubricants, containers and trash. Store these containers until they can be transported off-site for recycling, reuse or disposal at an approved site.

Equipment Maintenance

- Properly maintain equipment to prevent oil, gas and other discharges.
- Check hoses and fittings on a regular basis to prevent leaks or spills.
- Keep equipment clean and free of excess oil and grease.
- Conduct maintenance or repair work in designated areas away from drainages.
- Dispose of waste products properly and recycle when possible.
- When feasible, store idle equipment under cover from the weather.

Transport and Store Materials Properly

- Cover fuel, lubricant and trash storage containers to keep them clean and free of leaks, to avoid spills and to keep rainwater out of them.
- Store all fuel, fluids, lubricants and other materials in properly labeled and approved containers.

Spills

- Train all employees on proper spill containment and cleanup.
- Maintain an approved spill-containment and cleanup kit appropriate for all materials on the operation.

If a spill should occur, do the following, in this order:

- Identify the spilled product.
- Protect yourself and others. Wear protective clothing and equipment appropriate for the spilled materials used on the operation. Avoid coming in contact with any drift or fumes that may be released.
- If possible, stop the leak.
- If possible, contain the spill and keep it from spreading. Shovel a dike around the spill. Use absorbent material, such as sawdust or loose soil, to soak up fluid. Place a bucket under a hydraulic hose break. Keep the spill from flowing into any water (ditches, puddles, ponds, lakes and streams).

Spill Reporting

- A reportable quantity of spilled material (per EPA) is any amount that creates sheen on the waters of the U.S., or 25 gallons or more of a petroleum product spilled on the soil.
- Contact your regional DEQ office for disposal guidance.

Report spills that are of a reportable quantity to the Oklahoma Department of Environmental Quality's 24-Hour Emergency Response Hotline 1-800-522-0206 or by mail at: Oklahoma Department of Environmental Quality, P.O. Box 1677, Oklahoma City, OK 73101-1677.

Part 9. Wetlands

Forest wetlands are considered environmentally sensitive areas. Forest practices have the potential to impact wetlands, so special attention to the proper use of BMPs is essential to protect water quality and the functions of these systems. This section includes a brief summary of specific recommendations to protect wetland sites. Additional information about wetlands, permit requirements and implications for forestry practices is contained in the supplemental publication titled "Forested Wetlands in Oklahoma – Federal Regulations and Other Recommended Practices."

Introduction

Oklahoma's bottomland hardwood forests, including wetlands, are productive forest ecosystems that provide multiple functions and ecological values and that can be managed for commercial timber production without compromising this valuable resource (Figure 25). Although many sites classified as bottomlands may be wetland-like, they may not necessarily be "wetlands" in the strictest legal sense. *Jurisdictional wetlands* may be found anywhere in the state if specific wetlands criteria are met – they are not limited to obscure flooded or remote, marshy areas.

Silviculture is recognized as a land use compatible with the protection of wetland functions and values. Although wetlands are federally regulated, normal forestry operations in wetlands – including but not limited to soil bedding, site preparation, harvesting and minor drainage (see section below) – are exempt from the permit requirements under Section 404 of the Clean Water Act Amendments of 1977, provided that the activities:

- Qualify as "normal silviculture;" and
- Are part of an "established" silvicultural operation; and
- Do not support the intent to convert any waters of the U.S. to a use that it was not previously subject, for example from forestry to agriculture; and
- Follow the 15 Mandatory BMPs for road construction (see page 50) and the six mandatory BMPs for site preparation (see page 53); and
- Contain no toxic pollutant listed under Section 307 of the Clean Water Act in the discharge of dredge or fill materials into waters of the United States.

Legal Definition of Wetlands

The U.S. Army Corps of Engineers (Corps) (Federal Register 1981) and the U.S. Environmental Protection Agency (EPA) (Federal Register 1980) jointly define wetlands as: *"Those areas that are inundated or saturated by 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 generally include swamps, marshes, bogs and similar areas."*

The Corps, using the *Federal Manual for Delineating Jurisdictional Wetlands*, established the following criteria for wetlands delineation. All three of these conditions must be present under normal circumstances for an area to be classified as a jurisdictional wetland:

- **Hydrophytic Vegetation –** plants that have the ability to grow, effectively compete, reproduce and/or persist in anaerobic soil conditions.
- **Hydric Soils –** soils that are saturated, flooded or ponded long enough during the growing season for anaerobic conditions to develop.
- **Wetland Hydrology –** inundated by water sufficient to support hydrophytic vegetation and develop hydric soils.

Types of Wetlands

A variety of water features may be associated with wetland habitats (Figure 26).

Four major wetland types that might be found associated with forestlands in Oklahoma are listed below:

- Freshwater marshes/depressional wetlands occur in depressions in the landscape, or where changes in the surface topography result in groundwater discharge. Examples include branch bottoms and lower slopes.
- Riverine wetlands occur along streams and rivers and in floodplains that are flooded periodically, but can be dry during parts of the year. Examples include creek and river bottoms.
- Deep-water swamps occur as woody wetlands where flooding is more pronounced and water above the soil surface is normal. Examples include cypress breaks and sloughs.
- Fringe wetlands occur along lakeshores and ponds.

Figure 25. Wetlands.

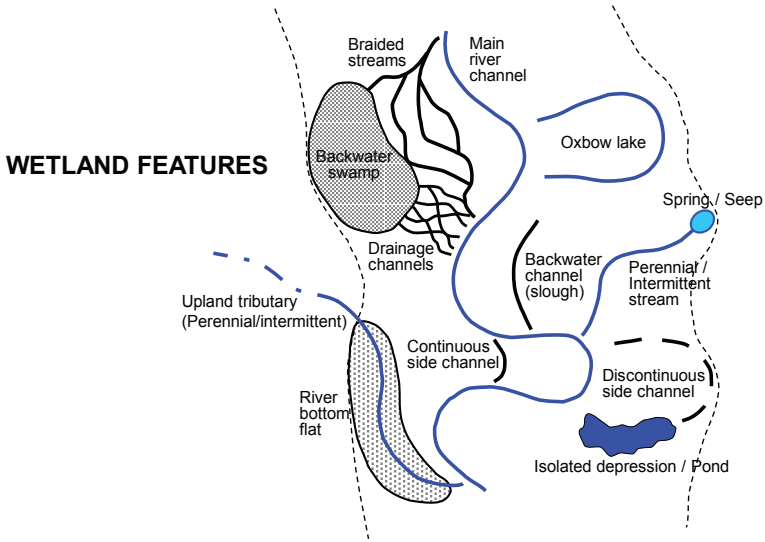

Figure 26. Schematic of Floodplain Physiographic Features (Modified from Mitsch and Gosselink, 1993 and Hodges, 1998).

Section 404 Permit and the Silvicultural Exemption

Section 404 of the Clean Water Act Amendments of 1977 establishes programs to regulate the discharge of dredged or fill material into waters of the U.S., including wetlands. Section 404 of the Act requires a federal permit before dredged or fill material may be discharged into U.S. waters unless the activity is exempt from Section 404 regulation (e.g., certain farming and forestry activities).

A forestry-related activity will require a 404 permit if it results in the conversion of a wetland to a non-wetland. Landowners who wish to change land use, or who feel an activity may change land use or are uncertain about the permit exception status of a forestry activity should contact the Tulsa District of the U.S. Army Corps of Engineers, Regulatory Office, 404 Clean Water Permit Section, 1645 South 101st East Avenue, Tulsa, OK 74128-4609, 918-669-7401 (http://www.swt.usace.army.mil/Missions/Regulatory.aspx. If the activity is on a farmed wetland or on agricultural land, the local office of the USDA Natural Resources Conservation Service (NRCS) is the appropriate initial contact (http://www.nrcs.usda.gov/wps/portal/nrcs/site/ok/home/).

Normal silvicultural activities conducted as part of established, ongoing forestry operations do not require a Section 404 permit so long as the appropriate measures are implemented. Normal activities include, but are not limited to, road construction, timber harvesting, mechanical or chemical site preparation, reforestation, timber stand improvement and minor drainage. "Appropriate measures" include the 15 Mandatory BMPs for road construction and the 6 BMPs for silvicultural site preparation activities in forested wetlands. If an activity was not intended to discharge dredged or fill material, but does so anyway (for example, an activity causes excessive erosion with the sediment being washed into a wetland), then the operator is in violation of Section 404.

Established Silvicultural Operations

Established or ongoing silvicultural operations are exempt from 404 permit requirements, whereas similar activities associated with conversion of forestland to other non-forest uses may require a permit. Ongoing silvicultural operations are normally part of a forest management system planned with conventional rotations for a property, or are introduced as part of an established operation. A specific activity itself need not have been ongoing, as long as it is introduced as part of an ongoing operation. Evidence of use of the property for forestry purposes may help in determining whether an operation is ongoing and whether the activities are actually silvicultural in nature (Greis 2010). Examples may include, but are not limited to, the following:

- A history of timber harvesting with either natural or artificial regeneration;
- The landowner is engaged in some type of forest management activity, such as boundary and road maintenance, firebreak construction and maintenance, fire, insect and disease control or stand improvement practices;
- The presence of stumps, logging roads, landings or other indications of established operations that will continue to be on the site;
- Explicit treatment of the land as commercial timberlands by government agencies under zoning, tax, cost-share and regulatory programs;
- Certification under the National Tree Farm System, the Forest Stewardship Program, the Sustainable Forestry Initiative, the Forest Stewardship Council or similar program;
- Preparation of a forest management plan;
- Ownership and management by a timber company or individual whose objectives include timber production.

Minor Drainage

Minor drainage refers to installation of ditches or other water control facilities for temporary dewatering of an area. Minor drainage is considered a normal silvicultural activity in wetlands to temporarily lower the water level and minimize adverse impacts on a wetland site during road construction, timber harvesting and reforestation activities. Minor drainage does not include construction of a canal, dike or any other structure that continuously drains or significantly modifies a wetland or other aquatic area.

Minor drainage is exempt from an individual 404 permit if it is part of an ongoing silvicultural operation and does not result in the immediate or gradual conversion of a wetland to an upland or other uses. Artificial drainage must be managed. Once silvicultural activities have been completed, the hydrology that previously existed must be restored by closing drainage channels.

Planning

Planning for timber harvesting is an often-overlooked step in silvicultural activities. When working in wetlands or similar areas, advanced planning is essential. To facilitate planning, identify and mark the location of water bodies and other sensitive areas using aerial photographs, topographic maps, soil surveys or wetlands delineation maps.

Streamside Management Zones for Wetlands

Streamside management zones should be established and managed around the perimeter of all major drainages and open bodies of water (e.g., stream channels, oxbow lakes, sloughs) contained within wetlands. The recommended minimum SMZ width is 50 feet, with a wider SMZ around sensitive areas. Inside the SMZ, maintain a minimum basal area of 50 square feet per acre.

Forest Roads

Mandatory Best Management Practices for Forest Roads in Wetlands

Construction or maintenance of forest roads in wetlands (and other jurisdictional waters of the U.S.) must be in accordance with the Corps' mandatory best management practices to retain 404 permit-exemption status. Roads must ensure that flow and circulation patterns and chemical and biological characteristics of waters of the U.S. are not impaired, the reach of the waters of the U.S. is not reduced and any adverse effect on the aquatic environment will be otherwise minimized. The 15 BMP practices listed below are not voluntary – they are required – when operating in wetlands. The following section is excerpted directly from Corps guidance.

Thirty-three CFR Part 323.4 (discharges not requiring permits) provides that any discharge of dredged or fill material that may result from any of the following activities is not prohibited by or otherwise subject to regulation under section 404:
(1) (i) Normal farming, silviculture and ranching activities such as plowing, seeding, cultivating, minor drainage and harvesting for the production of food, fiber and forest products, or upland soil and water conservation practices…
(6) 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 to assure that flow and circulation patterns and chemical and biological characteristics of waters of the U.S. are not impaired, that the reach of the waters of the U.S. 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, temporary access roads and skid trails in waters of the U.S. shall be held to the minimum feasible number, width and total length consistent with the purpose of specific silvicultural operations and local topographic and climatic conditions.
ii. All roads, temporary and permanent, shall be located sufficiently far from streams or other water bodies (except portions of such roads that must cross water bodies) to minimize discharge of dredged or fill material into waters of the U.S.
iii. The road fill should be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows.
iv. The fill should be properly stabilized and maintained to prevent erosion during and following construction.

v. Discharges of dredged or fill material into waters of the U.S. to construct a road fill should be made in a manner that minimizes the encroachment of trucks, tractors, bulldozers or other heavy equipment within waters of the U.S. (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. should be kept to a minimum.
vii. The design, construction and maintenance of the road crossing should not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.
viii. Borrow material should be taken from upland sources whenever feasible.
ix. The discharge should 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 should be avoided if practical alternatives exist.
xi. The discharge should not be located in the proximity of a public water supply intake.
xii. The discharge should not occur in areas of concentrated shellfish population.
xiii. The discharge should not occur in a component of the National Wild and Scenic River System.
xiv. The discharge of material should consist of suitable material free from toxic pollutants in toxic amounts.
xv. All temporary fills should be removed in their entirety and the area restored to its original elevation.

Permanent Roads

Minimize the construction of permanent roads in wetlands.

- Construct and maintain roads according to the 15 Mandatory BMPs.
- Plan the access system prior to construction. Whenever possible, avoid crossing streams, sloughs and other sensitive areas by planning alternative routes.
- Consider relocating poorly designed or constructed sections of an established road system that may lead to water pollution during and after the management activity.
- If applicable, construct roads well before the management activity to allow roads to stabilize before use.
- Construct fill roads only when necessary. Road fills should be as close as possible to natural ground level and should include adequate cross-drains for surface water flow.
- Locate borrow pits outside SMZs and jurisdictional wetlands.
- Stabilize soils around bridges, culverts and low-water crossings. When natural stabilization will not occur quickly, stabilize fill material with grass seed, rock or mulch.
- Construct fill roads parallel to water flow, where possible.
- Increase the load-bearing capacity of the soil and reduce rutting by using a geo-textile fabric or geo-grid material in critical locations.

- Use wooden mats where needed to minimize rutting. Make stream crossings at right angles to the channel when possible, and do not impede stream flow.
- Minimize sediment production when installing stream crossings.
- Restrict unnecessary access when roads are wet.
- Road ditches should not feed directly into stream channels.

Temporary Roads and Skid Trails

- Construct and maintain temporary roads in forested wetlands according to the 15 Mandatory BMPs.
- Favor temporary roads instead of permanent roads when possible. Properly constructed temporary roads have less impact than permanent roads on the hydrology of forested wetlands.
- Stabilize wet areas with mats constructed of wooden planks, timbers, logs, pallets, metal grating, pipe or other materials that increase the load-bearing capacity of the soil and provide traction.
- Remove temporary road fill and other materials, and restore the area to its original elevation upon completion of operations.

Road Maintenance

As mandated by the Clean Water Act, forest roads in jurisdictional wetlands must be constructed and maintained in accordance with the following BMPs in order to retain 404-permit exemption status.

- Inspect and maintain all drainage structures, especially following unusually heavy rainfall.
- Keep ditches, culverts and other water flow structures free of debris.

Timber Harvesting Operations

Conduct harvesting operations with consideration to season, stand composition, soil type, soil moisture and the type of equipment used.

- Harvest during dry periods if possible, to minimize rutting.
- Use low pressure, high flotation tires or wide tracks to minimize damage to the residual stand.
- Keep skidder loads light, or suspend logging, when rutting is evident. Ruts should not be present to the extent they impede, restrict or change natural water flows and drainages, or create channelized flow. A determination of *excessive* rutting is highly subjective and should only be made by a forester or other qualified individual who can evaluate rutting extent and depth, soil type, direction and position, and other local factors.
- Fell trees away from watercourses if possible.
- During harvesting, remove any obstructions in channels resulting from harvesting operations.
- Limit operations on sensitive sites and in SMZs during periods of wet weather.

Site Preparation

Site preparation activities in forested wetlands for the establishment of pine plantations[1] may or may not require a Clean Water Act Section 404 permit.

The following forested wetlands BMPs are designed to minimize the impacts associated with mechanical 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 below as "Permit Required"). The Corps prescribes the following six mandatory BMPs for all mechanical site preparation activities undertaken for pine plantation establishment on jurisdictional wetlands[2]:

1. **Minimize soil disturbance –** 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. **Avoid soil compaction –** Conduct activities in such a manner as to avoid excessive soil compaction and maintain soil tilth.
3. **Limit erosion and runoff –** Arrange windrows in such a manner as to limit erosion, overland flow and runoff.
4. **Keep logging debris out of SMZs –** Prevent disposal or storage of logs or logging debris in SMZs.
5. **Maintain natural contours and drainage –** Maintain the natural contour of the site and ensure that activities do not immediately, or gradually, convert the wetland to a non-wetland.
6. **Exercise water management –** Conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts.

Forest Chemicals

Use of chemical treatment should be limited within an SMZ associated with a wetland. If state and federal laws regarding the proper use of silvicultural chemicals are adhered to and manufacturers label directions followed, the careful use of chemicals should not jeopardize an SMZ or the water it is designed to protect.

- Use tree injection or direct application methods of pesticides, including herbicides, and apply only in accordance with label instructions.
- Apply fertilizers with careful consideration of rate, timing and frequency of application to prevent soil or water pollution.
- Prevent the drift, spillage, seepage or washing of chemicals into the SMZ or watercourse.

- **Avoid soil compaction – Conduct activities in such a manner as to avoid excessive soil compaction and maintain soil tilth.**

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1 These guidelines were developed for the establishment of pine plantations and do not apply to, restrict or require a permit for mechanical site preparation for the establishment of hardwood plantations.

2 These BMPs firmly establish that forestry site preparation activities including shearing, raking, moving logging slash, windrowing, piling, etc., are part of normal silviculture; therefore, implementation of the mechanical site preparation BMPs does not constitute "land clearing" or other non-exempt activities.

Part 10. Glossary

Artificial Regeneration – The establishment of a forest through intentional means, such as by planting tree seedlings or by direct seeding.

Basal Area – An estimate of the cross-sectional area (in square feet) occupied by trees as measured at 4.5 feet above ground level.

Bedding – A site preparation method, usually applied in wet areas, in which special disking equipment forms a small ridge of soil as an elevated planting bed.

Berm – A ridge or mound of soil that may influence water quality in a positive way or a negative way. A berm is used to create dips and water bars to divert runoff from forest roads, or to provide road closure. A berm unintentionally left along road edges may prevent proper drainage and result in erosion and gullying.

Best Management Practices (BMPs) – Forest management practices or combinations of practices established by a state or designated management agency to prevent or minimize the amount of pollution generated by non-point sources, thus maintaining a level compatible with water quality goals.

Borrow Pit – An area from which soil is removed, generally to build up a roadbed during construction.

Braided Stream – A stream system with multiple and frequently interconnected channels, generally with a low stream gradient, broad valley and well-defined floodplain.

Bridge Mat – Heavy wooden timber or fabricated steel panels placed across a narrow stream or drainage channel to serve as a temporary bridge for access by logging equipment during harvesting activities, to prevent soil erosion and minimize channel disturbance.

Broad-Based Dip – A surface drainage structure for active roads that consists of a long and wide hump or grade change in a road that diverts runoff water away from the road onto the forest floor while allowing vehicles to maintain normal travel speeds.

Bucking – Sawing of felled trees into predetermined lengths.

Chemical Site Preparation – The use of herbicides to control plant competition to prepare an area for establishment of a future forest, either by natural or artificial means.

Chopping – A site preparation method in which brush species and logging debris are pushed down and flattened close to the ground by the use of rolling drum choppers or mechanical brush choppers in preparation for reforestation.

Clearcutting – The total removal of a merchantable tree crop from an area.

Commercial Forest Land – Forestland with these characteristics:

1. Bearing or capable of bearing timber of commercial character;
2. Economically available now or prospectively available for commercial use; and
3. Not otherwise withdrawn from such use.

Contour – An imaginary line on the land surface that is at a constant elevation.

Cross-Drain Culvert – A metal, concrete or plastic pipe or wooden structure designed to carry upslope ditch runoff under the road and onto the forest floor.

Crowned Roads – Constructing the road surface with slopes away from the centerline so that water drains to each side.

Cut and Fill – Process of earth moving by excavating part of an area and using the excavated material to build up adjacent embankments or road fill areas.

Disk-Harrowing or *Disking* – Site preparation by cultivating the soil and breaking up surface vegetation using heavy disking equipment.

Drainage Structure – An intentional modification of the land surface that facilitates the movement of water away from an area.

Dredge Material – Earthen material that is excavated or dredged from waters of the United States.

Ephemeral Drain – Small depressions in the terrain commonly referred to as drains, draws or ephemeral channels that may or may not have a well-defined channel, and which generally carry runoff only in response to storm flow following heavy rains.

Erosion – The process by which soil particles in situ are detached and transported by water and gravity to some downslope or downstream deposition point.

Felling – The process of severing trees from stumps.

Fill Material – Any material used for the primary purpose of replacing an aquatic area with dry land or of changing the bottom elevation of a water body.

Filter Strip (or *Buffer Strip*) – A vegetated area of land separating a water body from forest management activities that slows runoff and helps remove pollutants.

Fireline – A barrier used to stop the spread of fire, constructed by removing fuel or rendering fuels inflammable using water or fire retardant.

Ford – A natural or constructed stream crossing suitable for shallow streams with stable bottoms.

Forest Chemicals – Chemical substances or formulations that perform important functions in forest management, and include fertilizers, insecticides, herbicides, fungicides, rodenticides, nematocides and other chemical products.

Forest Land – Land bearing forest growth or land from which the forest has been removed but which shows evidence of past forest occupancy and which is not now in other uses.

Forest Landowner – An individual, combination of individuals, partnership, corporation, non-federal government agency or association of whatever nature that holds ownership interest in forestland.

Forest Practice – An activity relating to the growing, harvesting or processing of forest tree species on the land.

Forest Road – An access route for vehicles into forestland.

Furrowing – A site preparation method involving the plowing of a trench in preparation for reforestation.

Grade – The slope of a road, usually expressed as a percent.

Gully – An eroded channel generally caused by past land-use practices, which generally carries water only in response to runoff events.

Harvesting – The removal of merchantable trees from an area.

Harvest Unit (*Setting*) – The forestland area within a tract that is designated for cutting, in which skidding is directed to one or more landings on a forest road.

Haul Road – A primary road used for transporting harvested timber from a site.

Herbicide – Any chemical substance or mixtures of substances intended to prevent the growth of or promote the removal of targeted trees, shrubs, herbaceous or other competing vegetation.

Hydrophytic Vegetation – Plants growing in water or in soil too waterlogged for most plants to survive.

Inslope – To slope a road surface to cause drainage to flow toward the uphill side; generally used on the inner curves of roads in steep terrain.

Intermittent Stream – A watercourse that flows in a well-defined channel during wet seasons of the year, but not the entire year. They generally exhibit signs of water flow sufficient to move soil material, litter and fine debris.

Jurisdictional Wetlands – Areas subject to the regulations of the Clean Water Act; generally low-lying topographic features that collect, store or flow water frequently enough to favor a majority of plants that are adapted to saturated soil conditions.

Lakes and Ponds – Water bodies where water stands with relatively little or slow movement.

Landing – A place where logs are assembled for temporary storage, loading and subsequent transportation.

Litter – The uppermost, slightly decayed layer of organic matter on the forest floor.

Log Deck – A place where logs or tree-length material are processed for loading and transporting.

Logging – The felling and transportation of standing trees from the forest to a delivery location, or landing, for ultimate movement to a wood processing plant.

Logging Debris or *Slash* – The unwanted or unutilized and generally unmarketable accumulation of woody material, such as large limbs, tops, cull logs and stumps that remain as forest residue on the land after logging.

Low Water Bridge – A stream crossing structure built with the expectation that during periods of high water or floods the water will flow over the structure.

Mechanical Site Preparation – Cutting of all standing material with blades, choppers or other heavy equipment to prepare an area for the establishment of a future forest by artificial or natural means.

Mulching – Covering exposed forest soil using organic residues such as grass, straw or wood fibers, to help control erosion or facilitate seed germination

Natural Drainage – A naturally occurring conduit for the flow of water downslope.

Natural Regeneration – The establishment of a forest through natural seeding or vegetative means such as stump sprouting (coppice).

Non-point Source (NPS) Pollution – Sources of water pollution without a well-defined point of origin, which:

1. Are induced by natural processes, including precipitation, seepage, percolation and runoff;
2. Are not traceable to any discrete or identifiable facility (contrast this term with *Point Source Pollution*); and
3. Are better controlled through the utilization of best management practices, including processes and planning techniques.

Nutrients – Mineral elements in the forest ecosystem such as nitrogen, phosphorus or potassium usually in soluble compounds that are present naturally or may be added to the forest environment as forest chemicals, such as fertilizer.

Ordinary High Water Mark – The mark on the shores of all waters found by examining the beds and banks to ascertain where the presence and action of waters are so common, and usual, and so long continued in all ordinary years, as to mark upon the soil a distinct character.

Organics – Particles of vegetative material in water that can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

Outslope – To slope a road surface along a hill so that drainage is across the road toward the downhill side.

Outstanding Resource Waters (ORW) – Waters of the state designated by the Oklahoma Water Resources Board that constitute outstanding resources or are of exceptional recreational and/or ecological significance as described in Oklahoma's Water Quality Standards, OWRB Rule 785:45-3-2(a).

Perennial Stream – A watercourse that flows in a well-defined channel throughout most of the year under normal climatic conditions, and is generally of sufficient size to support aquatic organisms.

Permanent Road – A forest access road that serves as a main artery in a network of roads, and which receives periodic maintenance to assure its continued utility.

Pesticide – Chemical substances used to control or eliminate target weed and pest species, including herbicides, insecticides, fungicides, rodenticides or nematocides.

Point Source Pollution – A source of water pollution generally characterized by discrete and confined conveyances from which discharges of pollutants into navigable waters can be controlled by effluent limitations. Contrast this term with *Non-point Source Pollution*.

Pollution – Contamination or other alteration of the physical, chemical or biological properties of any natural waters of the State, or such discharge of any liquid, gaseous or solid substance into any waters of the State as will or is likely to create a nuisance or render such waters harmful, or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational, or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life. [O.S. Title 82: §1084.2(1)]

Prescribed Burning – The controlled use of fire to reduce or eliminate the unincorporated organic matter of the forest floor, as well as low, undesirable vegetation or competing woody species.

Puncheon – Logs or slash placed in a roadbed or trail for stability on swampy ground.

Regeneration – Renewal of a forest by either natural or artificial means.

Registered Forester – A person who is registered by the Oklahoma Board of Registration for Registered Foresters as being qualified to engage in professional forestry practices by virtue of their education and experience.

Right-of-Way Timber – Logs cut on rights-of-way in the construction of forest roads, drainage ditches, pipelines or power lines.

Rill – A small channel on slopes where excess water collects and flows into larger channels. Channelized flow is the normal flow pattern on forestlands, rather than sheet flow.

Riparian – The land adjacent to and pertaining to the banks of streams, rivers or other water bodies.

Ripping or *Subsoiling* – A site preparation method using tractor-drawn or mounted equipment with heavy teeth to break up compacted or impermeable soils or soft rock to aerate and loosen the soil and otherwise improve the site for reforestation.

Rocked Ford – A stream crossing occurring naturally or constructed intentionally to provide a stable location for vehicles to cross watercourses with minimal impact.

Rolling Dip – A surface drainage structure for active roads on steeper grades that consists of a hump or grade change in a road that diverts runoff water away from the road onto the forest floor while allowing vehicle movement at reduced speeds.

Rootraking – A site preparation method using a heavy-toothed implement mounted on a tractor for collecting logging debris into piles or windrows in preparation for reforestation.

Rutting – Depressions in the soil resulting from the passage of heavy equipment under wet conditions.

Scarify – To break up the forest floor and topsoil preparatory to natural or direct seeding, or the planting of seedlings.

Sediment and Sedimentation – Suspended or deposited soil particles and organic material deposited downhill or downstream by surface runoff.

Shearing – A site preparation method that involves the cutting of brush, trees and other vegetation at or near the ground line using tractors equipped with angled or V-shaped cutting blades. The resulting woody debris may then be broadcast burned, piled and burned or left in place prior to reforestation.

Sheet Flow – Runoff from a rainfall event that is intense enough to cause direct overland flow prior to entry to a receiving stream. Sheet flow is uncommon in forested areas.

Sidecast – The act of moving excavated material to the side and depositing such material laterally to the line of movement of the excavating machine. The term also refers to such excavated material.

Significant Risk – Site conditions that have resulted in, or very likely will result in, a measurable and/or significant degradation of water quality, i.e., a violation of water quality standards.

Silvicultural Activities (EPA interpretation) – All forest management activities, including intermediate cuttings, harvesting, log transportation and forest road construction.

Silviculture – The science and art of cultivating forests based upon the knowledge of the life history and general characteristics of forest trees; the principles, theories and practices for protecting and enhancing the establishment, growth, development and utilization of forests for multiple benefits.

Site Preparation – A general term for removing unwanted vegetation and other material when necessary, and any soil preparation, carried out before reforestation.

Skidding – The use of equipment to drag or otherwise move harvested trees from the stump to the log deck or landing for processing, loading and hauling.

Skid Trail – A temporary pathway used by skidding equipment to move harvested trees from the stump to the log deck or landing. These pathways are used multiple times.

Slope – The steepness of the land expressed as the amount (in percent) of vertical fall per 100 feet of horizontal distance.

Slough – A poorly defined channel in a swamp, bog, marsh or river system, often without a clearly defined inlet or outlet and treated as an ephemeral area.

Soil Productivity – Refers to the output or productive capability of a forest soil to grow timber crops.

Spot Cultivation – A site preparation method where the only soil disturbance occurs at each tree planting or seeding location.

*Spring (*or *Seep)* – A discrete site where ground water flows naturally from the subsurface onto the land or into surface waters.

Streambank – The elevated areas along each side of a channel that generally confine flowing waters to the streambed, except under high-flow conditions.

Stream Classification – Classifying surface waters by variation of flow and other pertinent hydrologic and physical characteristics essential to the development of BMPs, due to the variable nature of stream systems and forest practices. Three classes of flow are recognized in Oklahoma:

Perennial means that part of the drainage network that provides flow at all times except during extreme drought.

Intermittent means that part of the drainage network that provides flow continuously during some seasons of the year but little or no flow during other seasons.

Ephemeral means that part of the drainage network that provides flow only during or immediately after periods of rainfall.

Streamside Management Zone (SMZ) – An area adjacent to the banks of perennial and intermittent streams where extra precaution is necessary in carrying out forest practices in order to protect streambank integrity, surface vegetation and water quality.

Temporary Road – A forest road intended for short-term use that generally provides access from timberland sites to a permanent road and which is closed after project completion.

Three-in-One Plowing – A site preparation method involving the use of specialized tractor-mounted equipment that rips and cultivates the soil, and elevates the tree-planting row in one pass.

Tributary – A body of water that contributes flow to waters of the U.S., and is characterized by the presence of the physical indicators of a bed and bank, and an ordinary high water mark.

Water Bar – A diversion ditch and/or hump or berm in an inactive trail or road to divert surface water runoff into roadside vegetation, leaf litter, a ditch or dispersion area to minimize the volume and velocity that causes soil movement and erosion.

Water Pollution (EPA definition) – Contamination or other alteration of the physical, chemical or biological properties of any natural waters of the state, or other such discharge of any liquid, gaseous or solid substance into any waters of the state which will, or is likely to, create a nuisance or render such water harmful or detrimental or injurious to public health, safety or welfare, or to domestic, commercial, industrial, agricultural, recreational or other legitimate beneficial uses, or to livestock, wild animals, birds, fish or other aquatic life.

Water Quality Standards (EPA definition) – Established state requirements for water quality management, containing three major elements:

1. The beneficial use(s) to be made of the water (e.g., recreation, drinking water, fish and wildlife propagation, industrial or agriculture);
2. Criteria to protect those uses; and
3. An anti-degradation statement for protecting existing high quality waters.

Watershed – All land and water within the confines of a drainage basin.

Waters of the United States – All interstate waters, including interstate wetlands; all other waters such as intrastate lakes, rivers, streams (including intermittent streams), mudflats, sandflats, wetlands, sloughs, prairie potholes, wet meadows, playa lakes, or natural ponds which are susceptible to use in interstate or foreign commerce, recreation, fish and shellfish production and industrial use; impoundments of waters just described; tributaries of waters just described; and wetlands adjacent to waters just described.

Wetlands (Corps of Engineers and EPA definition) – Areas that are inundated or saturated by 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 generally include swamps, marshes, bogs and similar areas.

Windrowing – A site preparation method where logging debris and non-merchantable woody vegetation is piled in rows.

Wing Ditch or *Turnout* – An extension of a road's drainage ditch away from the road that provides periodic relief of concentrated water flow onto the forest floor to disperse and filter stormwater runoff.

Part 11. Appendices

Major Federal Legislation

Clean Water Act Amendments of 1977. United States Code Title 33 s/s 121 et seq. (amended the Federal Water Pollution Control Act of 1972).

Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). United States Code Title 7, Chapter 6.

Endangered Species Act of 1973. United States Code Title 16, Section 1531-1544.

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United States Code: Title 33 Navigation and Navigable Waters – Chapter 26: Water Pollution Prevention and Control – Subchapter IV: Permits and Licenses – Section 1344: Permits for Dredged or Fill Material (Abbreviated 33 USC 1344). Also refer to www.epa.gov/owow/wetlands/laws.

United States Code of Federation Regulations: 33CFR-Part 323 (specifically 323.4). *Permits for Discharges of Dredged or Fill Material into Waters of the United States*. http://www.nap.usace.army.mil/Portals/39/docs/regulatory/regs/33cfr323.pdf

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- How to Install a Forest Road Culvert
- Introduction to Road Stream Crossings
- Designing and Constructing Large Rocked Fords on Forest Streams
- Constructing Small Rocked Fords on Forest and Farm Roads in Oklahoma
- A Handy Gauge for Forest and Farm Road Construction Measurements
- Using Bridgemats for Stream Crossings in Forestry Operations