



GUIDE TO FORESTRY

**BEST MANAGEMENT  
PRACTICES IN TENNESSEE**

TENNESSEE  
DEPARTMENT  
OF  
AGRICULTURE  
DIVISION OF  
FORESTRY  
2003





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## INTRODUCTION

An Abundant supply of clean water has long been one of the main benefits derived from Tennessee's forested watersheds. Protecting water quality and preventing soil erosion during forestry operations is an important responsibility for forest managers, forest landowners and loggers.

In order to meet the objectives of the Federal Clean Water Act - "to restore and maintain the chemical, physical and biological integrity of the Nation's waters," Tennessee has adopted Best Management Practices (BMPs) for forestry operations. These are practical nonregulatory guidelines to be used during the construction of roads, log landings, and skid trails to minimize the environmental impact of forest management activities. Best Management Practices offer a flexible, preventive and nonregulatory approach to protecting water quality during forestry operations. They are designed to be low-cost, practical and easily applicable to all forestry operations.

This BMP handbook was prepared as a reference guide for those who work in the forest, own forestland or are concerned about forest management practices and their effect on the environment. It is designed to assist foresters, loggers and land managers with each aspect of BMP installation. Topics covered include forest road design, construction and maintenance; special considerations for streamside management zones; timber harvesting and site preparation; and wetlands.

For help with BMP training and technical guidance, contact any of the Division of Forestry's offices listed on page 45.



## FORESTRY BEST MANAGEMENT PRACTICES

As reported in the Tennessee Department of Environment and Conservation's 305(b) reports, forestry operations do not contribute significantly to soil erosion and water pollution in Tennessee. However, poor road location, construction and logging practices can result in unnecessary environmental problems. Only where roads, skid trails, log landings and stream crossings expose soil does the possibility exist for the transport of sediment into streams.

Non-point Source (NPS) pollution is water pollution resulting from runoff associated with land management activities. This runoff can carry natural and manmade pollutants into waterways, wetlands and ground water. Non-Point Source pollution can result from agriculture, forestry, mining, construction and urban runoff. The Tennessee Department of Agriculture maintains a nonregulatory NPS program to address agriculture and forestry water quality issues. NPS pollution resulting from mining, construction and urban sources are addressed through regulatory programs.

### **NPS Pollutants from Forestry Activities Include:**

- **Sediment** is soil material suspended in water resulting from erosion. Sediment from runoff causes cloudy water and covers the bottom of streams and lakes. These conditions inhibit the ability of aquatic organisms to breathe, feed and reproduce.
- **Organic matter** is debris from living organisms. Examples of organic matter include leaves, twigs, limbs, tree tops and other plant material. Organic matter in waterways can impede navigation, restrict water flow, reduce oxygen and change water color.
- **Pesticides** are chemicals used to control undesirable insects, disease, vegetation, animals, or other life forms. If used incorrectly, pesticides can be toxic to aquatic plants and animals.
- **Nutrients** are chemical elements required by plants/animals to live and grow. Fertilizer is an example of a nutrient that could be used in forestry operations. If used incorrectly, fertilizer can be toxic to aquatic life, cause undesirable aquatic plant growth and change water color.

- **Elevated Water Temperature** can be caused by direct sunlight resulting from tree canopy removal adjacent to waterways. Elevated water temperature inhibits aquatic organisms ability to breath, feed and reproduce.

**Best Management Practices (BMPs) are forest management practices developed as practical and effective means to minimize or prevent nonpoint source pollution. This manual is a practical guide explaining how BMPs should be implemented.**



## LOCATING, CONSTRUCTING, AND RETIRING FOREST ROADS

Forest roads are a necessary and expensive part of forestry management activities. Roads are constructed for moving timber products to market, providing access for fire protection and making the forest available for recreation and other uses (figure 1). Forest roads, if not properly planned and constructed, are one of the single greatest sources of sediment. Forest roads should be designed, constructed and retired in a way that prevents sediment from entering waterways. There are three types of forest roads:

- **Temporary roads** are the most common type of forest road. Temporary roads are designed for short-term use during a specific project such as timber harvesting. When harvesting is completed, temporary roads are usually closed and stream crossing structures are removed.
- **Permanent seasonal roads** are considered part of the permanent road system. These roads are generally narrower than permanent all-season roads, are built to lower design standards and have minimal surface gravel. Use of permanent seasonal roads may be restricted when conditions are excessively wet or during periods of freezing and thawing.
- **Permanent all-season roads** usually have gravel surfaces and are designed for year-round use.



**Figure 1.** *A well located, constructed and maintained system of forest roads will be safer, allow longer operating periods, and reduce operating and maintenance costs.*

### **BMP Guidelines for Road Location:**

- Use soil surveys and topographic maps to develop a road plan prior to any road construction.
- Minimize the length of road to be constructed by using existing roads where practical and if properly located.
- Locate roads as far from water bodies as possible and practical. Avoid locating roads at the confluence of streams.
- Avoid building roads in streamside management zones (SMZ) and sensitive areas.
- Avoid or minimize stream crossings. If crossings are unavoidable, roads should cross streams at right angles if possible (refer to Stream Crossings, page 17).
- Locate roads on upper slopes near the crest of ridges to promote drainage. Avoid locating roads on top of ridges.
- Fit the road to the topography by following natural contours and keeping grade between 2 and 12 percent. Avoid road sections with 0 percent grade.

### **BMP Guidelines for Road Construction:**

- Construct new roads several weeks or longer in advance of logging or other activity to allow the road bed time to settle before carrying heavy traffic.
- Avoid road construction during periods of wet weather.
- Construct roads on grades of 2 to 12 percent where possible. Steeper grades are acceptable for short distances only if adequate water control/drainage structures are provided.
- Minimize runoff at stream crossings. Runoff from roads should not directly discharge into a stream channel (refer to Stream Crossings, page 17).
- Control runoff from roads using such techniques as varying the slope of the road, crowning, outsloping, wing ditches, sediment control structures, broad-based dips, water bars and/or cross-drain culverts.
- Push trees and brush cleared for road corridors to the downhill side of the road to assist in trapping sediment.
- Maximize sunlight exposure to the road surface.
- Minimize soil disturbance during road construction by keeping road width, right-of-way and stream crossings to a minimum.



- Revegetate exposed soils in potential problem areas that could generate sediment. Examples of areas potentially needing revegetation include culverts, stream crossings and fill areas (refer to Stabilization and Revegetation of Disturbed Areas, page 27).

#### **BMP Guidelines for Road Retirement:**

- Construct water bars or other drainage structures immediately after active logging has ceased. If logging will be delayed for a substantial period of time, construct temporary drainage and erosion control structures (refer to Drainage from Road Surfaces, page 9).
- Upon completion of logging, remove temporary bridges, temporary culverts, and pole fords; remove sediment and debris from ditches, ditches and culverts; and revegetate problem areas (Refer to Stabilization and Revegetation of Disturbed Areas, page 27).
- Use mulch and/or seed with lime and fertilizer when needed to prevent soil erosion (figure 2). Recommendations concerning lime and fertilizer are available from University of Tennessee Agricultural Extension Service county offices.



**Figure 2.**  
*Cuts, fills, and road surfaces are potential problem areas that could generate sediment. Revegetate potential problem areas at the first opportunity allowed by weather and traffic.*



## DRAINAGE FROM ROAD SURFACES

Providing for adequate water drainage is a critical element of road construction and design. Properly drained roads produce less sediment, are easier to maintain, can be used for longer periods of time and allow more timely resumption of logging activities. Methods and structures for providing effective road drainage include varying the grade of the road, crowning, insloping and outsloping, water turnouts, broad-based dips, water bars and cross drain culverts.

### BMP Guidelines for Road Drainage:

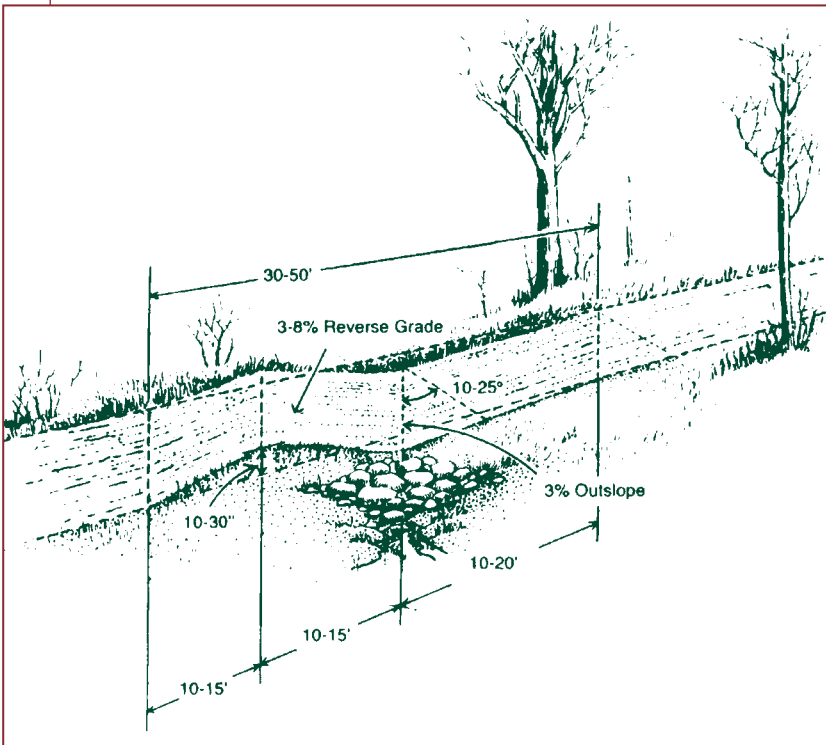
- When possible, vary road grade to reduce concentrated flow in road drainage ditches, culverts and on fill slopes and road surfaces (table 1).

<b>Table 1.</b>	
<b>Recommended Intervals for Changing Grade and Broad-Based Dips*</b>	
Road Gradient (%)	Approximate Distance Needed Between Grade Change or Broad-Based Dip (ft.)
2	300
3	233
4	200
5	180
6	167
7	157
8	150
9	144
10	140
11	136
12	133

\*Computed from the formula: Spacing in feet = 400/slope % + 100 feet

- Crown roads when located on flat or gently sloping terrain. Crown roads when crossing a ridge.
- Outslope roads 2 to 3 percent when side slopes are at least 10 percent.

- Inslope roads 2 to 3 percent on extremely steep slopes and sharp turns as a safety measure. Inslope roads require drainage ditches, broad-based dips and/or culverts to carry water to downhill sides of road.
- Install water turnouts (wing ditches) to move water quickly away from roads. Water turnouts should route water into undisturbed areas allowing filtration before entering water bodies.
- Build broad-based dips during road construction at the recommended intervals (table 1).
- If soils are highly erodible, armor broad-based dips with large crushed rock, gravel or other suitable material. Install riprap or other suitable materials at the outlet of the dip to slow and absorb runoff (figure 3).



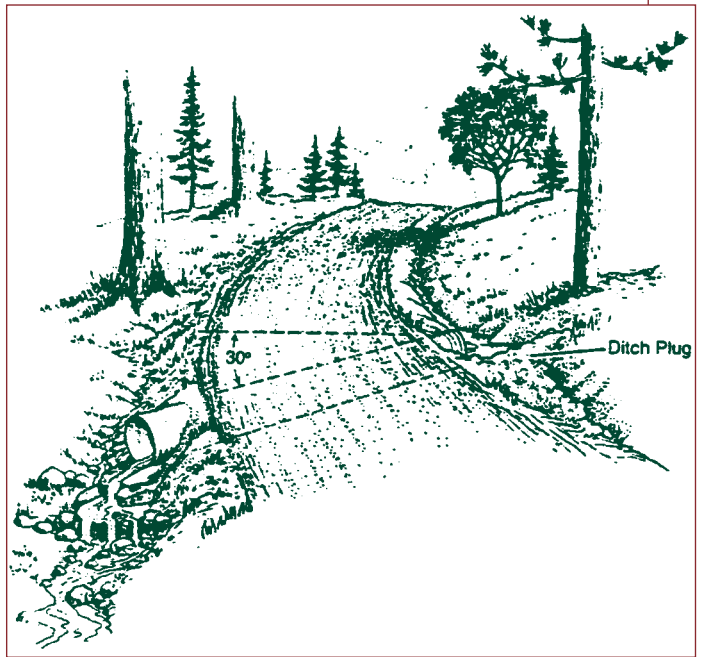
**Figure 3.**  
*Broad-based dips are designed to move water off roads and facilitate the ease of vehicle use.*

- Install cross-drain culverts at recommended intervals to carry water in drains, small streams and side ditches across roads (table 2).

Table 2. Recommended Spacing of Pipe or Cross-Drain Culverts	
Road Gradient (%)	Spacing (feet)
2 - 5	300 - 500
6 - 10	200 - 300
11 - 15	100 - 200
16 - 20	100

- Install cross-drain culvert on a grade at least 2 percent more than the grade of the ditch it drains.
- Install cross-drain culvert on an approximately 30 degree angle down slope (figure 4).

**Figure 4.**  
*Proper culvert installation is required to maintain free water flow.*

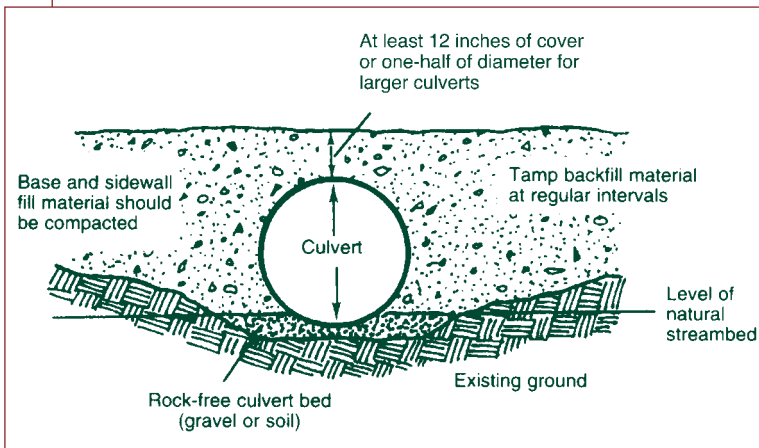


- Raise cross-drain culvert above ground level on the inlet end to allow sediment to settle. Provide a short fall at the outlet end so water will move away from the culvert.
- Keep cross-drain culvert inlets and outlets clear.
- Revegetate disturbed areas around cross-drain culverts soon after installation.

- Use cross-drain culverts adequately sized to handle drainage area above culvert location (table 3).

Table 3. Recommended Diameters of Culverts Based on Drainage Area			
CULVERT SIZE	AREA DRAINED - ACRES		
	Diam. in inches	Mountain Country	Rolling Country
15	1	6	11
18	2	9	18
21	3	14	28
24	5	20	39
30	8	36	71
36	14	59	115
42	20	89	175
48	29	125	250
54	40	175	345
60	55	230	455
66	70	295	585
72	85	375	735

- Compact soil on both sides of the culvert. Fill over the top should be at least half the diameter of the culvert but a minimum of one foot (figure 5).

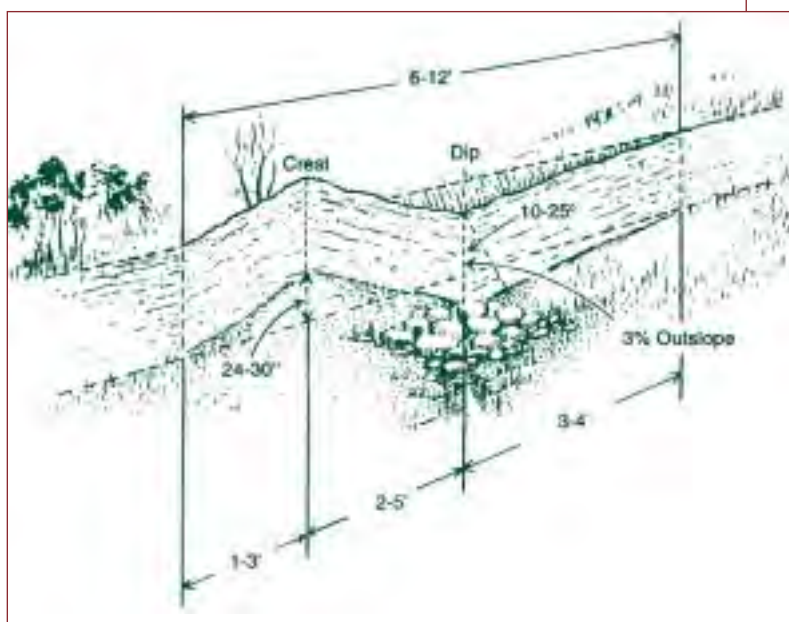


**Figure 5.**  
*Proper installation prevents culvert from being crushed by heavy loads.*

- Construct water bars at the recommended intervals on temporary roads or skid trails once forestry operations are complete (table 4 and figure 6).

Road Gradient (%)	Spacing in Feet
2	250
5	135
10	80
15	60
20	45
25	40
30	35
40	30

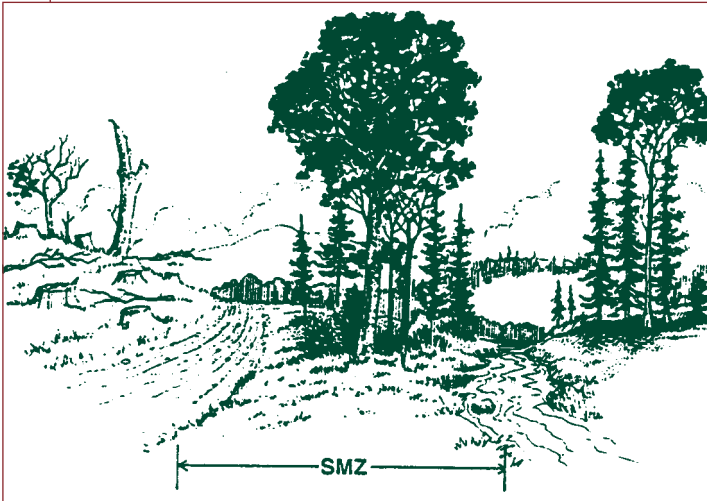
**Figure 6.**  
*Water bars are built at specific intervals depending on the road or skid trail gradient.*



- Water bars should have an outlet to carry water off road or skid trail.
- Water bars should be installed with a 20-30 degree angle.
- Revegetate water bars if they pose a potential water quality problem.

## ESTABLISHING STREAMSIDE MANAGEMENT ZONES

Streamside Management Zones (SMZs) are designated areas consisting of the stream and an adjacent area of varying width where management practices that might affect water quality are modified (figure 7). Streamside Management Zones filter sediment and nutrients from overland runoff, allow water to soak into the ground, protect stream banks and lakeshores, provide shade for streams and improve the aesthetics of forestry operations. Although SMZs are recommended primarily for water quality protection, these areas are also complex ecosystems that provide food, habitat and movement corridors for both aquatic and terrestrial communities.



**Figure 7.**

*A streamside management zone (SMZ) provides a relatively undisturbed buffer area to trap and filter out suspended sediments in overland flow from disturbed areas before these particulates reach the stream.*

## PERENNIAL AND INTERMITTENT STREAMS

Any perennial or intermittent stream should be protected with a SMZ. Such protection is needed even if water does not flow in the channel year round. The following types of streams need SMZs.

- **Perennial streams** contain surface water within a well-defined channel. These streams flow practically year round under normal weather conditions and usually provide permanent habitat for aquatic plants and animal life.
- **Intermittent streams** contain water within a well-defined channel and flow in response to seasonal variations in precipitation (40 to 90 percent of the time) following a major rainstorm or as long as ground water is abundant.

## BMP Guidelines for Perennial and Intermittent Streams:

- SMZ planning should be done before the beginning of the timber harvest.
- The width of SMZs should be a minimum of 25 feet from the disturbed area to the stream bank for zero percent slope and 20 additional feet for each additional 10 percent of slope (table 5). This applies to both sides of the stream (total minimum width of 50 feet).

**Table 5. SMZ Width Guidelines**

Slope of Land Between Disturbed Area and Stream (in percent)	Recommended SMZ Width (in feet)
0	25
10	45
20	65
30	85
40	105
50	125
60	145

- Do not remove any trees within the SMZ if such removal would result in soil potentially getting into streams. If trees are harvested within SMZs, maintain 50 percent of the overstory canopy within the SMZ.
- Stream channels should not be used as roadways for any type of equipment or vehicles.
- Avoid operating any harvesting equipment or vehicles within the SMZ. Timber harvested within the SMZ should be cabled and winched out.
- Mark SMZ boundaries prior to harvest where they can clearly be seen.

### Perennial Streams

- Contains surface water and flows most all year
- Well-defined stream channel
- Aquatic plants and animal life present
- Requires a SMZ

### Intermittent Streams

- Flows during wet seasons of the year, but not entire year
- Well-defined stream channel
- Aquatic insects and animal life present, but sometimes difficult to assess during dry periods
- Requires a SMZ
- Exhibit signs of water velocity sufficient to move soil material, litter and fine debris

### Ephemeral Streams

- Flows in a diffuse manner during and for short periods following precipitation
- No well-defined stream channel, commonly referred to as drains, draws, dry washes or wet weather conveyances
- Aquatic plants and animal life not present
- Does not require SMZ, but care should be taken to insure that sediment is not transported from the drain into waterbodies downstream
- Leaf, twig and other forest litter is typically present or sporadically displaced



## EPHEMERAL STREAMS OR WET WEATHER CONVEYANCES

Ephemeral streams or wet weather conveyances flow in a diffuse manner over depressions in the forest floor, usually not within a well defined channel, only in direct response to a major rainfall and only for a short period after rainfall ceases. Flow in these water courses is not driven by springs, seeps or other ground water sources.

The establishment of SMZs is not necessary for ephemeral streams or wet weather conveyances. However, sediment deposited into these features could be transported into waterbodies. Operators should modify and limit sediment producing activities near ephemeral streams or wet weather conveyances.

### **BMP Guidelines for Ephemeral Streams or Wet Weather Conveyances:**

- Avoid skidding during wet conditions within drains except as infrequent planned crossings.
- Avoid locating roads in drains except where necessary for crossings.
- Do not empty road runoff into drains.
- Minimize soil exposure and compaction to protect ground vegetation.

## SENSITIVE AREAS

Sensitive areas are site-specific natural or topographic features of consequence to an aquatic resource including, but not limited to, fragile soils, wetlands, sink holes, seeps, springs and heads of springs, landslides, old gully systems and known locations of officially listed threatened or endangered species. (Additional information on threatened and endangered species is available from the contacts listed on page 50.) Activity that disturbs or disrupts such areas and promotes potential water pollution should be avoided. Activity is not necessarily excluded from these areas; however, caution and judgment must be used when these areas are encountered.

### **BMP Guidelines for Sensitive Areas:**

- Avoid skidding within sensitive areas.
- Avoid locating roads within sensitive areas.
- Do not empty runoff from disturbed areas directly into sensitive areas.
- Minimize soil exposure and compaction to protect ground vegetation.

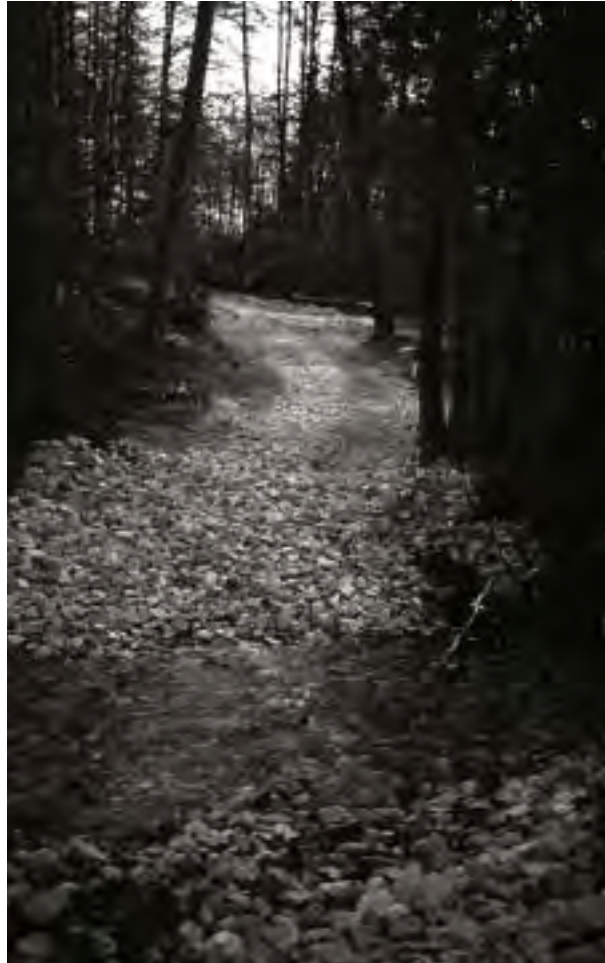
## STREAM CROSSINGS

Stream crossings are often necessary for access to forestlands. Crossing a stream or wet weather conveyance improperly can result in erosion and introduction of sediment into a stream (figure 8). **Best Management Practices for stream crossings also apply to ephemeral streams and wet weather conveyances.**

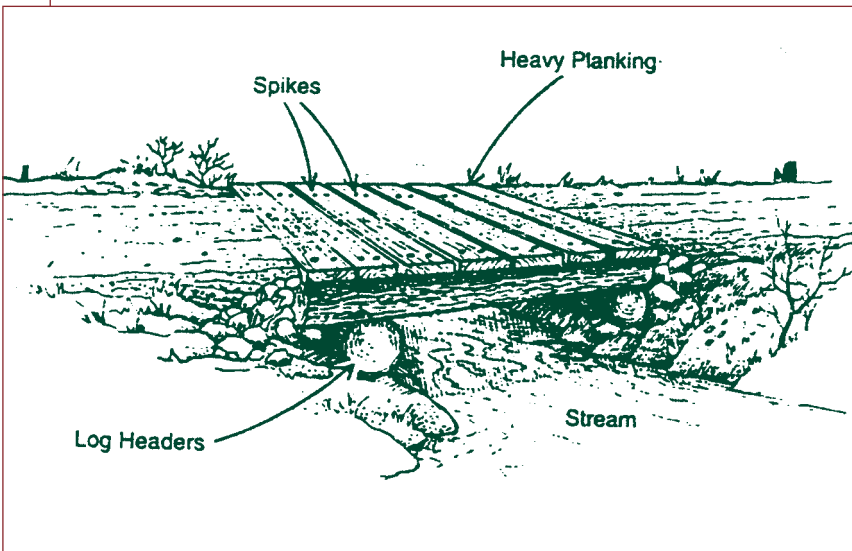
### BMP Guidelines for Stream Crossings:

- Avoid or minimize stream crossings. If crossings are unavoidable, roads should cross streams at right angles if possible.
- Locate crossings on the straightest section of streams to minimize disruption of normal stream flow.
- Avoid locating crossings at the confluence of streams.
- Design crossings to minimize disruption of movement of aquatic life.
- Approaches to stream crossings should rise away from streams to minimize erosion during high water and should be graveled to prevent washing and rutting.
- Install broad-based dips and wing ditch turnouts to turn water off roads before entering the stream.

**Figure 8.**  
*Forest managers, loggers and forest landowners should carefully plan stream crossings before logging begins.*



- **Fords:**
  - Use fords for haul roads, not for skid trails.
  - Locate fords where stream banks are low.
  - Fords should have a solid bottom.
  - Where necessary, establish a smooth hard surface by using gravel to establish a low water crossing. Material should not significantly impede stream flow or release significant amounts of fine material into the stream.
- **Culverts:**
  - Culvert size should accommodate the area to be drained (Table 3, page 12). Temporary culverts may be smaller in size than those otherwise specified but must be removed at the completion of logging activity.
  - Install culverts in a manner that minimizes disturbance of stream channels and prevent sloughing of stream banks. Stabilize fill material with riprap and/or vegetation to prevent soil movement.
  - Inspect culverts periodically to ensure that they remain free of debris and other blockages.
  - Install culvert outlets on grade with the bottom of the stream channel to allow for free movement of fish and aquatic life.



**Figure 9.**  
*A low-cost log  
and plank bridge*

- **Bridges:**
  - Locate bridges across narrow points of the stream on firm soils.
  - Protect banks from sloughing when constructing and removing temporary bridges.
  - Do not cover bridges with soil (figure 9).
  - Use temporary bridges or other crossing structures for skid trails. Crossings for skid trails should be designed to prevent equipment and logs from entering stream channels (figure10).

**Figure 10.**  
*Temporary bridges  
and crossing  
structures should be  
removed when no  
longer needed for  
timber harvesting  
operations.*



## LOCATING AND CONSTRUCTING LOG LANDINGS

Log landings are areas used to collect and process logs for transport to a mill. Due to concentrated traffic and heavy equipment, log landings experience a high degree of soil disturbance, soil compaction and rutting. Storm water runoff and surface erosion may increase on these exposed areas and, depending on their locations, could impact water quality. If logging equipment is not properly serviced and maintained, runoff from log landings may contain toxic materials from fuels and lubricants.

### **BMP Guidelines for Log Landings:**

- Use existing landings from previous timber harvests, if properly located.
- Locate landings outside of SMZs and away from stream channels and sensitive areas.
- Slope landings 2-5% to allow for drainage.
- Prevent sawdust, chips, fuels and lubricants from entering drains where runoff may wash the material into streams.
- Revegetate landings if they pose a potential water quality problem (figure 11).
- Install drainage and sediment control structures to divert runoff.



**Figure 11.**  
*Landings should be revegetated if they pose a potential water quality problem.*



## LOCATING AND CONSTRUCTING SKID TRAILS

Skid trails are paths established to transport logs or trees from the stump to a landing or log deck. Skid trails are for temporary use during the timber harvest. Improperly designed, located and constructed skid trails can produce large amounts of sediment. Water pollution can occur if sediment from skid trails enters water bodies.

### **BMP Guidelines for Building Skid Trails:**

- Minimize the number of skid trails; use existing trails if properly located.
- Locate skid trails on grades of 2 to 30 percent. Steeper grades are acceptable for short distances only if adequate water control/drainage structures are provided.
- Runoff from skid trails should not discharge into a stream.
- Control runoff from skid trails using such techniques as varying trail grade, water bars, wing ditches and/or sediment control structures.
- Prevent runoff associated with stream crossings. Avoid skidding across streams, drains, other wet areas, and sensitive areas; skid away from streams and drains. If crossing streams is unavoidable, use culverts or temporary crossing structures. Do not use fords to skid across streams.
- Do not operate skidders and other equipment in streams.
- Avoid skidding directly up or down hill; slant the course, follow the contour or use a “zigzag” pathway, if possible.
- Upon completion of logging, remove temporary bridges and culverts; remove sediment and debris from dips, ditches and culverts; revegetate potential problem areas.
- Use mulch, and/or seed with appropriate amounts of lime and fertilizer when needed to prevent soil erosion. Recommendations concerning lime and fertilizer are available from University of Tennessee Agricultural Extension Service county offices.
- Avoid ruts that risk channeling water into a stream.





## DEBRIS AND HAZARDOUS MATERIALS IN STREAMS AND LAKES

Trees, treetops and branches can block streams, cause channel erosion and introduce excessive organic matter into streams (figure 12). If not removed, logging debris has the potential to cause extensive flooding and alter stream channels.

### **BMP Guidelines for Limiting Logging Debris in Streams and Lakes:**

- Trees should not be felled in or across streams. Trees accidentally felled in or across streams should be removed in a manner that prevents channel and stream bank disturbance.
- Pull treetops far enough from waterways to prevent them from being washed back into waterways during high water.
- Do not drag trees and tops through a stream channel.
- Do not remove stumps and roots from stream banks.



**Figure 12.**  
*Avoid leaving  
logging debris in  
streams.*

Improper equipment servicing can introduce hazardous or toxic materials to the harvest site. Plan ahead when servicing harvesting equipment to ensure fluids and other materials do not spill and are disposed of properly.

**BMP Guidelines for Servicing and Maintaining of Logging Equipment:**

- Prevent oil and fuel spills. If a spill occurs, clean up all spilled materials, and contaminated soil and dispose of both properly. Information on proper spill containment and clean-up is available at the Tennessee Department of Environment and Conservation's Environmental Assistance Centers (EACs). You can be automatically transferred to the appropriate EAC by dialing 1-888-891-8332. After 4:30 pm and on weekends contact the Tennessee Emergency Management Agency (TEMA) at 1-800-262-3300. Ask that information be forwarded to personnel in the applicable EAC (refer to page 48 for individual EAC contact numbers and areas of responsibility).
- Improper waste disposal may be a criminal offense. Tennessee Code Annotated 39-14-408 addresses "vandalism," (including polluting another person's real property). Tennessee Code Annotated 39-14-105 addresses "grading of theft" (gradations of penalties based on value of theft or damage).





## SITE PREPARATION AND TREE PLANTING

Site preparation is used to control competing vegetation associated with forest stand regeneration. Many site preparation techniques expose soil and can cause soil erosion. The site preparation technique used depends on soils, slope, condition of the site, natural vegetation, tree species and cost.

Site preparation techniques can be grouped into three categories:

**Mechanical Site Preparation** controls undesirable vegetation through the use of equipment and/or mechanical implements. Mechanical site preparation methods can create significant areas of disturbed and exposed soil. Such methods are more appropriate on level to gentle slopes.

**Chemical Site Preparation** controls undesirable vegetation through the use of herbicides. Chemical site preparation is preferred in many situations since it does not disturb the soil. Herbicides can be successfully applied through aerial application or ground methods. Chances of off-site impacts are minimal when chemicals are used properly.

**Prescribed Fire** may be used alone or in conjunction with mechanical or chemical site preparation. A properly conducted prescribed burn consumes a portion of the litter layer without altering the soil. Such burns only slightly increase erosion potential. Very hot fires that expose much mineral soil on steep slopes may significantly increase erosion potential.

### **BMP Guidelines for Site Preparation:**

- Choose a site preparation method that will expose and disturb as little bare soil as possible.
- Favor chemical methods over mechanical methods on steep slopes and highly erodible soils.
- Establish SMZs between streams and site prepared areas to minimize the possibility of sediment or chemicals entering streams.

### **Mechanical Site Preparation:**

- Carry out all mechanical site preparation operations and tree planting along the contour of the land.

- Avoid operating mechanical site preparation and tree planting equipment on slopes greater than 30 percent. Slopes over 30 percent should be hand planted.

### **Chemical Site Preparation:**

- Follow all EPA label instructions on chemical containers and state laws.
- Never apply pesticides directly to water except when registered for application over water. Establish SMZs between streams and treatment areas to avoid airborne drift. Avoid the use of chemicals in or near sensitive areas.
- Consider weather conditions (such as temperature, wind speed and precipitation) and equipment capabilities to avoid herbicide drift.
- Calibrate spray equipment to apply chemicals uniformly and in correct quantities.
- Prevent chemical leaks from equipment. Check all equipment for leaking hoses, connections and nozzles.
- Mix and load chemicals outside of SMZs and sensitive areas.
- Rinse spray equipment and discharge rinse water only in areas that are part of the application site. Never rinse tanks or sprayers in or near streams.
- Dispose of chemical containers according to label instructions.

### **Prescribed Fire:**

- Locate windrows well away from drains to prevent materials from being washed into streams.
- Construct firelines on the contour in advance of prescribed burning.
- Plow firelines only as deep and wide as necessary to control the spread of the prescribed fire and to minimize soil disturbance.
- Construct water bars and wing ditches at recommended intervals on firelines to turn water into adjacent undisturbed areas (Table 3).



## FERTILIZATION

Forest fertilization is a valuable silvicultural practice that enhances tree survival and growth. The primary nutrients applied are nitrogen and phosphorus. Plan any forest fertilization to prevent direct applications and runoff into waterways. When conducted properly, forest fertilization poses little threat to water quality.

### **BMP Guidelines for Fertilization:**

- Determine appropriate amounts and types of fertilizer needed before application.
- Consider weather conditions (such as temperature, wind speed and precipitation) and equipment capabilities to avoid fertilizer drift into SMZ.
- Conduct all on-site fertilizer handling, such as mixing and loading, away from streams, ponds, wells, roadside ditches and sensitive areas.
- Clean up and/or contain all fertilizer spills immediately.
- Dispose of fertilizer containers/or excess fertilizer according to local, state and federal regulations and label requirements.



## STABILIZATION AND REVEGETATION OF DISTURBED AREAS

The purpose of revegetating disturbed areas is to reduce soil erosion. In combination with water control structures such as water bars, turnouts and broad-based dips, revegetation can help to limit soil loss and reduce nonpoint source pollution. Natural seeding from adjacent vegetation will colonize most exposed soil on disturbed areas. However, disturbed areas with the potential for soil erosion should be artificially revegetated by seeding.

### The Proper Seeding Mix

Different seeding mixes are needed for different situations and different planting dates. Usually a “temporary” seed mix is applied first and a “permanent” mix of seed is applied later to maintain continuous cover and to reduce erosion. A temporary species will come up, stabilize the soil surface quickly, and provide a thick cover. However, most are annuals and are short-lived. A more permanent mixture is needed to sustain the cover for several years. The permanent mix is not really permanent without mowing or bushhogging. Eventually the permanent mix will be replaced in several years by brush and trees.

A few of the recommended seed mixtures, pure seed seeding rates (accounting for seed purity and germination percentage) and seeding dates are outlined below.

#### 1. Temporary Seeding

a.	winter wheat	35 lbs/acre	Oct. 15 - March 1
b.	spring oats	35	Oct. 15 - March 1
c.	grain rye	35	Oct. 15 - March 1
d.	annual rye	5	Aug. 1 - Oct. 15
e.	browntop or foxtail millet	15	May 1 - July 1
f.	pearl millet	10	May 1 - July 1

#### 2. Permanent Mixtures on Less than 10% Slopes

a.	orchard grass and red clover or ladino clover	8 lbs/acre 6 2	Feb. 1 - May 1 or Aug. 1 - Oct. 15
b.	orchard grass and annual (Kobe) lespedeza	10 10	Feb. 1 - May 1 only
c.	switch grass and big bluestem and indiangrass and red clover and Korean lespedeza	1 2 3 4 5	May 1 - June 30

Orchard grass is recommended as a more wildlife friendly alternative to Kentucky 31 fescue on gentle slopes. If you have a shady area, consider using a creeping red fescue mix (option 3b). The vegetation in option 2c needs sunny conditions and will not thrive in deep shade. These grasses usually take longer to establish and also need more care than mixes with orchard grass or fescue. Lespedeza grasses can only be planted in the spring.

**3. Permanent Mixtures on Greater than 10% Slopes**

a.	KY 31 Fescue and flatpea or birdsfoot trefoil	30 lbs/acre 30 10	Feb. 1 - May 15 or Aug. 1 - Oct. 15
b.	creeping red fescue and white clover	20 2	Feb. 1 - May 15
c.	switch grass and partridge pea	8 5	May 1 - June 30

Even though fescue is not wildlife friendly, it is recommended on steeper slopes because of its ease of establishment with minimal site preparation and its hardiness during droughts. In particular, fescue is one of the better grasses for controlling erosion on logging sites with exposed slopes.

**4. Seeding Mixtures for Wet or Poorly-Drained Areas**

a.	redtop and alsike clover or birdsfoot trefoil	7 lbs/acre 6 6	Feb. 15 - June 30 or Aug. 1 - Oct. 1
b.	switch grass and alsike clover or birdsfoot trefoil	8 6 6	May 1 - June 30 or Aug. 1 - Oct. 1

**5. Seeding Mixtures with Native Species**

a.	switch grass and indiangrass and big bluestem and little bluestem and partridge pea	2 lbs/acre 2 1.5 1.5 5.0	May 1 - June 30
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Some landowners prefer using native grass species on their property. These grasses need a relatively good seedbed, require special care in seeding, have a narrow range of planting dates and take a year or more to establish. Generally, native grasses are used on log landings that are relatively flat, cultivated and in full sun. These mixtures will not thrive in shady areas. Native warm-season grasses are not a substitute for wildlife food plots. The grass provides nesting and escape cover only; with little wildlife nutritive value. These native seeds are sometimes hard to find and more expensive than other options. Additional information on native warm-

season greases and other wildlife habitat considerations is available from the Tennessee Wildlife Resources Agency offices listed on page 49.

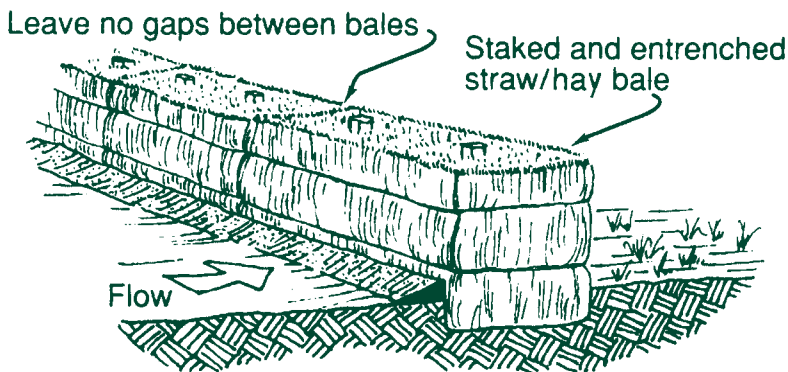
### **Preparing the Site for Seeding**

Before seeding, all the site work following the logging operation should be completed such as removing berms, installing water control structures and grading for proper drainage. The seedbed should be prepared, especially when exposed soils are hard and dry. Simple measures that can be used are back-dragging dozer or skidder blades, or using a farm tractor with a disk, harrow or rake. Good seedbed preparation will increase revegetation success and save money from repeated attempts to establish cover. Fertilization and liming are often effective in promoting growth on disturbed sites.

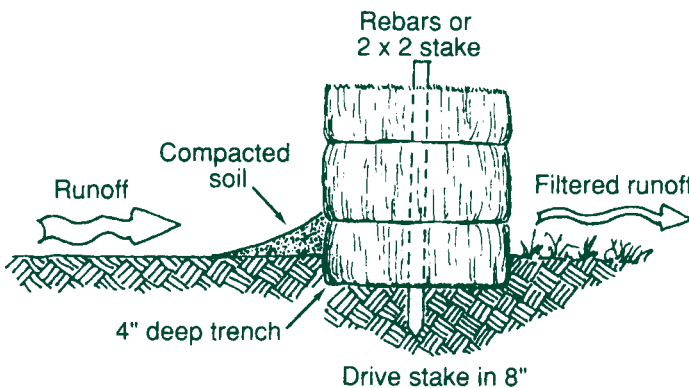
Seeding roads, skid trails and log landings reduces erosion and water pollution. Although the protection of water quality is the primary purpose of BMPs, landowner surveys indicate more satisfaction with the logging job when more attention is given to revegetating roads and landings. The “green” appearance of these areas shows that special care to control erosion is taken to ensure that the logging job is left in a desirable condition.

## SEDIMENT CONTROL STRUCTURES

Sediment control structures are natural materials, terrain features or manmade structures which trap and hold sediment. New sediment control products and techniques are continually being developed. New products that prove to be practical and effective can be used to trap and hold sediment. These structures can include straw/hay bale fencing, silt fencing and brush barriers (figure 13). Sediment control structures slow the flow of runoff and trap sediment until vegetation is established on the sediment source. Barriers can also be used to keep sediment out of sensitive areas. Place sediment control structures as a linear filter fence along the lower margin of an area of disturbed soil, such as a road, skid trail or log landing. The material must be placed to prevent water from running under it. Maintain, clean or replace sediment control structures until areas of exposed soil are stabilized. Sediment control structures should not be installed in stream channels.



**Figure 13.**  
*Use straw/hay  
 bale fencing to  
 slow runoff and  
 trap sediment.*





## WETLAND BEST MANAGEMENT PRACTICES

Wetlands are a valuable component of Tennessee's forest resource base, providing benefits and functions that are important to society and the natural environment, including:

- Filtering silt and other pollutants, recharging groundwater supplies, lessening the potential for erosion and reducing downstream flooding during periods of heavy rainfall;
- Producing valuable timber;
- Providing high quality fisheries and wildlife habitat; and
- Furnishing outdoor recreation opportunities.

### **Potential Impacts of Forestry Operations in Wetlands.**

Wetlands unique characteristics are maintained by a natural water ebb and flow. Forestry operations can potentially interrupt the natural movement of water in wetlands. Channelization activities over an extended period of time can cause conditions drier than normal. Fill materials and/or logging debris can impede natural drainage. Both of these conditions alter plant and animal species composition in wetlands. Other potential impacts of forestry operations in wetlands can also include accelerated soil erosion and soil compaction.

### **BMP Guidelines for Wetlands:**

#### **Forest Roads**

- Keep permanent and temporary access roads to the minimum number, width, and total length consistent with the purpose of the silvicultural operation.
- Locate all roads above and away from streams to minimize discharges of dredged or fill material into wetlands.
- Design the road fill with bridges, culverts or other drainage structures to prevent the restriction of expected flood flows.
- Stabilize and maintain the fill during and following road construction to prevent erosion.
- Design road stream crossings not to disrupt the movement of aquatic life.



- Take borrow material from upland sources whenever feasible.
- Remove all temporary fills in their entirety and restore the area to its original elevation.
- Provide for revegetation of roads following operations.

### **Streamside Management Zones**

- Establish SMZs at least 50 feet in width along both sides of all streams and open water.
- Locate roads and log landings away from streams and as far as practical from SMZs.
- Minimize the number of roads through SMZs.
- Do not remove any trees within the SMZ if such removal would result in soil potentially getting into streams. If trees are harvested within SMZs, maintain 50 percent of the overstory canopy within the SMZ.
- Avoid operating logging vehicles and equipment in the SMZ, minimize disturbance of the forest floor and protect the banks of streams and sloughs.
- Remove tops of harvested trees from streams and sloughs to allow unrestricted water flow.

### **Forest Harvesting**

- Plan logging during dry weather. Suspend harvesting operations when woods are flooded and during wet weather to reduce erosion, rutting and soil compaction.
- Locate log decks on elevated areas away from streams and as far as practical from SMZs. Keep log landings small and few in number.
- Use low ground pressure tires on skidders when available and concentrate skidding as much as possible on a few primary skid trails to minimize site disturbance and soil compaction.
- Avoid use of skidders in SMZs, and never skid logs through streams or sloughs.
- Revegetate log landings, skid trails and other disturbed areas if they pose a potential water quality problem.



## FEDERAL WATER QUALITY LEGISLATION AFFECTING FORESTRY ACTIVITIES IN TENNESSEE

### **Federal Water Pollution Control Act**

Water quality and forestry activities were first linked with the passage of the 1972 Federal Water Pollution Control Act, now commonly referred to as the Clean Water Act (CWA). Sections 319 and 404 within the CWA affect forestry activities. Section 319 required states to establish non-point source pollution programs. Section 404 deals with dredge and fill activities occurring in streams and wetlands.

### **How Section 319 Affects Forestry**

Amendments to the CWA specified that states could adopt either regulatory or nonregulatory programs for reducing water pollution discharges resulting from forestry activities. Nonregulatory programs, adopted by most states, are based on voluntary compliance with state water quality objectives. These programs often depend on educational and technical assistance for forest landowners that are enhanced by cost sharing or tax incentives. Regulatory programs impose mandatory restrictions on forest management practices and penalties for noncompliance. These programs tend to rely on inspections of forest management activities while the activities are in progress, as well as follow-up inspections to confirm compliance.

### **How 404 Affects Forestry Activities**

Section 404 of the CWA requires that a permit be obtained from the Corps of Engineers before a discharge of dredged or fill materials can be made into streams and/or wetlands in Tennessee. Although forestry activities that discharge these materials into wetlands are regulated, those activities are exempt if they meet the following conditions:

1. It is not part of an activity whose purpose is to convert a wetland into an upland where the flow or circulation of public waters may be impaired or the reach of the waters reduced.
2. It is part of an established or ongoing silvicultural, farming or ranching operation and not a new use to which the wetland was not previously subject.
3. It uses normal silvicultural, farming or ranching activities which are in compliance with state and federal BMPs.

4. It has not lain idle for so long that hydrological modifications will be necessary to resume operations.
5. It does not contain any toxic pollutants listed under Section 307 of the Clean Water Act.

A forestry activity or operation will require a 404 permit from the Corps of Engineers when:

1. The activity results in the immediate or gradual conversion of a wetland to an upland as a consequence of altering the flow and circulation or reducing the nation's waters.
2. The activity results in a change from the past, historical use of a wetland into a different use to which it was not previously subject where the flow or circulation of waters is impaired or the reach of the waters is reduced. Such a change does not meet the established ongoing requirement and causes the activity or operation to lose its exemption. An example would be an area where tree planting has been the established use and the landowner wished to convert the site for use as pasture, green tree reservoir, agriculture, real estate or aquaculture. In such cases the landowner must first obtain a 404 permit before proceeding with the change.
3. The area has lain idle for so long that hydrologic modifications are necessary to resume operations.

Section 404 specifies that in order to obtain the silvicultural exemption, forest roads and skid trails must be constructed and maintained in accordance with the following baseline BMPs in order to retain Section 404 permit exemption status for the road operation.

1. 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 topographic and climactic conditions.
2. All roads, temporary or permanent, shall be located sufficiently far from streams or other water bodies (except for portions of such roads which must cross water bodies) to minimize discharges of dredged or fill material into waters of the U.S.
3. The road fill shall be bridged, culverted or otherwise designed to prevent the restriction of expected flood flows.
4. The fill shall be properly stabilized and maintained during and following construction to prevent erosion.
5. Discharges of dredged and fill material into waters of the U.S. to construct a road fill shall be made in a manner that minimizes the encroachment of

trucks, tractors, bulldozers or other heavy equipment within waters of the U.S. (including adjacent wetlands) that lie outside the lateral boundaries of the fill itself.

6. In designing, constructing and maintaining roads, vegetative disturbance in the waters of the U.S. shall be kept to a minimum.
7. The design, construction and maintenance of the road crossing shall not disrupt the migration or other movement of those species of aquatic life inhabiting the water body.
8. Borrow material shall be taken from upland sources whenever feasible.
9. The discharge shall not take or jeopardize the continued existence of a threatened or endangered species as defined under the Endangered Species Act, or adversely modify or destroy the critical habitat of such species.
10. Discharges into breeding and nesting areas for migratory waterfowl, spawning areas and wetlands shall be avoided if practical alternatives exist.
11. The discharge shall not be located in the proximity of a public water supply lake.
12. The discharge shall not occur in areas of concentrated shellfish protection.
13. The discharge shall not occur in a component of the National Wild and Scenic River System.
14. The discharge of material shall consist of suitable material free from toxic pollutants in toxic amounts.
15. All temporary fills shall be removed and the area restored to its original elevation.



## STATE WATER QUALITY LEGISLATION AFFECTING FORESTRY ACTIVITIES IN TENNESSEE

### **Tennessee Water Quality Control Act**

The Tennessee Water Quality Control Act (TWQCA) prohibits any person from causing a condition of pollution in state waters or altering the physical, chemical, radiological, biological or bacteriological properties of state waters without the authority of a permit. A logging operation may be subject to the terms of this law. A forestry operation that creates a point source discharge is regulated by the Act. If the forestry operation is regulated by the Act, the logging practices must comply with all aspects of the law including the necessity to obtain any appropriate permit. Further, this law governs any logging practice that causes pollution to waters. Typically, any forestry operation that implements the Best Management Practices described in this manual will not likely create a point source discharge and therefore will be exempt from the Act. However, silvicultural activities may be conducted in such a manner to create a point source discharge. The following are some examples of logging practices that can create a point source discharge:

- improperly constructed or placed stream crossings;
- tree tops in streams or wetlands;
- the discharge or spill of petroleum products, herbicides, or other chemicals into waters;
- loose dirt, soil and sediment from haul roads or landings that enter waters;
- improperly constructed skid trails, haul roads or landings;
- altering a stream channel or wetlands;
- using a stream channel as a transportation route;
- operating heavy equipment in a stream channel or wetland.

The Tennessee Department of Environment and Conservation, Division of Water Pollution Control (TDEC-WPC), is the state agency responsible for “the abatement of existing ground and surface water pollution, the reclamation of polluted waters and the prevention of future pollution of waters in the state.” The Division has been empowered “to exercise general supervision and control over the quality of all state waters, to administer and enforce all laws relating to pollution of such waters and to administer and enforce all laws consistent with the purposes of Tennessee’s Water Quality Control Act (TCA 69-3-101).”

In 1995, TDEC and the Tennessee Department of Agriculture (TDA) entered into a memorandum of agreement for the purposes of “establishing a cooperative, comprehensive and efficient program of effective water quality protection associated with silvicultural and agricultural production activities”. The “cooperative and complementary expertise, resources, and authorities of TDA and TDEC are necessary to implement a successful water pollution protection program as may apply to these activities”.

TDA's primary role and function is to provide technical and financial assistance services associated with the design, installation and maintenance of BMPs and the determination of the effectiveness of BMPs. TDEC-WPC's role is the administration and enforcement of Tennessee's Water Quality Control Act.

### **How TWQCA Effects Forestry Activities**

- Exempts agriculture and silviculture (forestry) activities from general permitting requirements "unless there is a point source discharge from a discernible, confined and discrete water conveyance (TCA 69-3-120g)." Landowners are exempt from obtaining a permit for forestry activities on forest management operations.
- If the forest operation requires a federal §404 Permit, a state permit must also be obtained. The §404 Permit may be Certified by the State of Tennessee (which is called a §401 Certification). In this case, the §404 Permit is also the state permit. If the State of Tennessee does not certify the §404 Permit, an Individual Permit must be obtained from the Department of Environment & Conservation, Division of Water Pollution Control (Additional information on permitting is available from the Tennessee Department of Environment and Conservation Environmental Assistance Centers listed on page 48).
- Activities that involve working in a stream such as stream bank disturbance and alteration, gravel removal or bank stabilization require a Aquatic Resource Alteration Permit (ARAP) from the TDEC-WPC.
- Stream and aquatic habitat disturbances that result from forestry activities may be subject to a notice of violation, which requires operators to cease improper activities and/or unnecessary site disturbances. Fines may be imposed for refusal to comply with notices of violation.

### **Silvicultural Activity Stop Work Order**

The TWQCA was amended in 2000 giving the Commissioner of the Department of Environment and Conservation authority to issue a stop work order associated with silvicultural activities. Before a stop work order is issued, the operator will be given an opportunity to come into compliance, except when the Commissioner of TDEC deems otherwise necessary to address water pollution.

The following 3 conditions must exist before a stop work order can be issued.

1. An operator has failed or refused to use forestry best management practices (BMPs); and
2. A point source discharge has been created as a result of failure or refusal to use BMPs; and
3. Waters of the State have been polluted as a result of silvicultural activities.

A stop work order will remain in force until compliance is achieved. The operator must notify TDEC and TDA of any new timber harvesting operations for a period of two years after the issuance of a stop work order.



## REFERENCES AND FURTHER READING ON BEST MANAGEMENT PRACTICES

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## GLOSSARY

**best management practice (BMP)** - a practice or combination of practices which has been determined to be the most effective and practical means of preventing or reducing water pollution to a level compatible with water quality goals.

**broad-based dip** - a surface drainage diversion built into the bed of a haul road. Broad-based dips are specifically designed to intercept and divert surface water flow out of a dirt road while allowing vehicles to maintain normal haul speeds.

**channel** - a natural or manmade course that conveys water.

**contour** - an imaginary line on the surface of the earth connecting points of equal elevation or a line drawn on a map connecting points of equal elevation.

**cover** - any substance or material, such as grass, leaves, logging debris, or rock which overlies mineral soil and prevents raindrop erosion.

**culvert** - a conduit through which surface water can flow under roads.

**crowning** - road building technique slightly elevating the center of a road to allow water to drain into side ditches.

**ephemeral stream** - commonly referred to as drains, draws, dry washes or wet weather conveyances that typically have no well-defined channel and flow in a diffuse manner only during and for short periods following precipitation. Leaf, twig and other forest litter is typically present or sporadically displaced in the ephemeral area. Aquatic plants and animal life are not present in these areas.

**erodibility** - the relative tendency of soil to erode based on physical structure and other characteristics.

**erosion** - the process by which soil particles are detached and transported by water and gravity to some downslope or downstream deposition point.

**erosion rate** - a measure of soil movement usually expressed as tons per acre per year.

**fill slope** - the surface area formed where soil is deposited to build a road or trail.

**gully erosion** - erosion process whereby water accumulates in narrow channels and over short periods of time soil is eroded away to substantial depths (one foot or more).

**harvesting** - cutting and removal of timber products from forested lands which usually includes felling and bucking trees, skidding bucked and tree length logs, and loading logs at landings.

**herbicide** - a substance used to prevent, control, or kill vines, bushes, trees, or other vegetation.

**hydrology** - the science dealing with water on the surface of the land, in the soil, and in the atmosphere.

**infiltration** - the process by which water enters and passes through the forest floor and mineral soil.

**insecticide** - a substance used to prevent, control, or kill insects.

**intermittent stream** - a watercourse that flows in a well-defined channel during wet seasons of the year, but not the entire year. They exhibit signs of water velocity sufficient to move soil material, litter and fine debris. Aquatic plants and animal life are usually present, but sometimes are difficult to assess during dry periods.

**litter** - organic matter such as leaves, branches, and other dead plant material which overlies mineral soil in forested areas.

**log deck/landing** - an area, usually less than an acre in size, to which logs are skidded to an on-site mill or bunched for loading onto trucks for transport out of the woods.

**mulch** - a layer of plant residue or other materials covering the land surface which conserves moisture, holds soil in place, minimizes temperature fluctuations, and aids in establishing plant cover. Examples include: hay, straw, bark, woodfibers.

**non-point source pollution** - pollution of water which is:

- carried or conveyed by natural processes including precipitation, seepage, percolation, and runoff;
- not traceable to a distinct or identifiable source; and
- better controlled through the application of good management practices.

**outfall protection** - a rip-rap or aggregate placed at the outlet of a culvert or water control device to protect that area from erosion due to the force or velocity of water from the outlet.

**outsloping** - an effective means of rapidly draining forest roads surfaces by tilting the road surface toward the downhill side at the rate of 1/4 inch per foot of road width or 2 to 3 percent.

**overland flow** - waterflow across the ground surface caused by inability to infiltrate the soil.

**percolation** - movement of water through the soil profile by gravity flow.

**perennial stream** - a watercourse with surface water that flows in a well-defined channel throughout most of the year under normal climactic conditions. Some may dry up during drought periods. Aquatic plants and animal life are normally present and easily found.

**permeability** - that quality of the soil which transmits infiltrated water deeper into the profile. Permeability decreases with depth of the mineral soil.

**pesticide** - any substance used to prevent damage by, control, or kill animal or plant pests. Examples include insecticides, fungicides, herbicides, and rodenticides.

**point source pollution** - pollution of water which is traceable to a distinct or identifiable source such as effluent draining from a pipe into a lake or stream.

**prescribed burning** - deliberate use of fire as a tool to reduce hazardous fuel, prepare sites for planting, improve wildlife habitat, control vegetation and disease, or achieve other silvicultural objectives.

**regulatory program** - a water quality management program under which laws and regulations are imposed by enforceable regulation of forestry activities and use of best management practices.

**rill erosion** - erosion in which numerous small channels only several inches deep are formed.

**riparian area** - that portion of the land along streams where water has a major and direct influence on the land and its vegetation AND the land and vegetation have a direct and major influence on water.

**riprap** - aggregate placed on erodible sites to reduce the impact of rain or surface runoff.

**road cut** - a portion of land surface or area from which soil has been removed or will be removed by excavation; the depth below original ground surface to an excavated surface.

**road segment** - an indefinite length of road such as that portion of road between sequential control points.

**scarify** - to break up the forest floor and top soil to create conditions suitable for germination of seed.

**sediment** - soil material suspended in water resulting from erosion.

**sedimentation** - deposition or settling out of soil particles from suspension in water.

**sensitive area** - site-specific natural or topographic features of consequence to an aquatic resource including but not limited to fragile soils, wetlands, sink holes, seeps, springs and head of springs, land slides, old gully systems and known locations of officially listed threatened or endangered species.

**sheet erosion** - removal of a fairly uniform layer of soil from the soil surface by overland (surface) flow.

**silvicultural activity** - any practice or activity related to regenerating, growing, or harvesting trees for production of forest products and related benefits.

**site preparation** - modification of a site for tree planting by controlling undesirable vegetation and/or cultivating the soil. Site preparation may be carried out by either chemical and/or mechanical methods.

**skid trail** - an ungraded path in the woods along which wheeled or tracked vehicles or animals drag logs to log decks for processing or loading.

**streamflow scour** - erosion of stream channels and banks caused by the flow of running water.

**streamside management zone (SMZ)** - a designated area that consists of the stream itself and an adjacent area of varying width where management practices that might affect water quality, fish, or other aquatic resources are modified. Streamside management zones are areas of closely managed activity, not areas of exclusion.

**transpiration** - loss of water into the air from leaves and other aerial plant parts by evaporation.

**truck road** - an access road usually constructed for removal of timber from the woods to public road by truck.

**voluntary program** - a water quality management program under which forestry practices and use of best management practices are not enforced by laws and regulations but which are expected to be adopted voluntarily by land managers and forest operators.

**water bar** - a structure constructed into a skid trail for achieving effective drainage, especially on temporary roads and trails.

**watershed** - a drainage basin; an area of land from which a stream or other body of water gets its water supply; an area bounded on all sides by water parting and draining into a watercourse or other body of water. A watershed may be as small as the area that feeds water into a farm pond or as large as the Mississippi River Basin.

**wing ditch** - a water turnout or diversion ditch constructed to move and disperse water away from a road and side ditches into adjacent undisturbed areas so that the volume and velocity of water is reduced on the road surface.



## CREDITS, CONTRIBUTORS AND SOURCES OF INFORMATION

**Photographs courtesy of:** Bob Baker and Robin Bible  
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Division of Forestry

**Tables 1** Modified from  
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**Tables 2 & 4** Haussman and Pruitt, 1978

**Table 3** Walbridge and Bentley, 1976

**Table 5** Trimble and Sartz, 1957  
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**Figures 3, 4, 5, 6, 7, & 9** Turton et al. 1992

**Figure 13** Wisconsin Department of Natural Resources, 1997

### Stabilization and Revegetation of Disturbed Areas

The University of Tennessee  
Agricultural Extension Service  
Dept. of Forestry, Wildlife & Fisheries

**Sources of Information:** Tennessee Dept. of Agriculture, Div. of Forestry  
Tennessee Dept. of Environment & Conservation,  
Div. of Water Pollution Control  
University of Tennessee Agricultural Extension Service

The following served on the Forestry Working Group that provided guidance and editorial comment during the development of this manual. Their expertise and contribution is greatly appreciated.

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**Reggie Reeves** TN Dept. of Env. & Cons., Division of Natural Heritage  
**Tony Gant** TN Forestry Assoc., Pulp & Paper Rep.  
**Steve Bond** TN Forestry Assoc., Sawmill Rep.  
**Dwight King** TN Forestry Assoc., Master Logger rep.  
**Mike Butler** TN Conservation League  
**Wayne Clatterback** Univ. of TN Ag. Extension Service



## DIVISION OF FORESTRY AREA OFFICES

**MAIN MAIL ADDRESS: P.O. Box 40627, Melrose Station, Nashville, TN 37204**  
**STREET ADDRESS: Ellington Agricultural Center**  
**440 Hogan Rd., Nashville, TN 37220 PHONE: (615) 837-5520**

Carter, Johnson and Sullivan Co  
P.O. Box 906, Elizabethton, TN 37644  
(423) 542-9221

Hamblen, Cocke and Jefferson Co  
P.O. Box 265, Jefferson City, TN 37760  
(865) 475-7788

Blount, Loudon and Monroe Co  
332 Sanderson St., Alcoa, TN 37701  
(865) 981-2399

Roane and Morgan Co  
4314 Roan State Hwy, Rockwood, TN 37854  
(865) 354-0258

Claiborne & Union Co  
2178 Hwy 25 East, Suite 1, Tazewell, TN 37879  
(423) 526-2992

Rhea, Bledsoe and Van Buren Co  
P.O. Box 384, Dayton, TN 37321  
(423) 775-0251

Fentress, Cumberland and Pickett Co  
2670 Highway 127 South, Crossville, TN 38572  
(931) 484-4227

Clay and Overton Co  
P.O. Box 226, Livingston, TN 38570  
(931) 823-2428

DeKalb, Putnam and White Co.  
390 S. Lowe, Ste 10  
Cookeville, TN 38501-4702  
(931) 528-6813

Dickson, Houston and Humphreys Co  
P.O. Box 179, Erin, TN 37061  
(931) 289-4527

Hancock, Hawkins and Grainger Co  
P.O. Box 121, Rogersville, TN 37857  
(423) 272-7130

Greene, Unicoi and Washington Co  
P.O. Box 202, Jonesborough, TN 37659  
(423) 753-2851

Scott and Campbell Co  
209 N. Indiana Ave., LaFollette, TN 37766  
(423) 566-3715

Knox, Sevier and Anderson Co  
P.O. Box 2666, Knoxville, TN 37901  
(865) 594-6432

Meigs, McMinn and Polk Co  
P.O. Box 943, Athens, TN 37371  
(423) 744-2818

Grundy, Marion, Coffee, Franklin and Moore Co  
P.O. Box 234, Dunlap, TN 37327  
(423) 949-3821

Bradley, Hamilton and Sequatchie Co  
P.O. Box 4817, Cleveland, TN 37320  
(423) 478-0335

Macon, Smith, Trousdale and Jackson Co  
P.O. Box 13, Carthage, TN 37030  
(615) 735-0300

Cannon and Warren Co  
P.O. Box 732, McMinnville, TN 37110  
(931) 473-2418

Sumner, Davidson, Robertson, Williamson  
and Wilson Co  
6087 Fire Tower Rd., Nashville, TN 37221  
(615) 352-2704

Cheatham, Stewart and Montgomery Co  
P.O. Box 814, Clarksville, TN 37040-0680  
(931)552-3909

Hardin and Wayne Co  
1485 Firetower Lane, Savannah, TN 38372  
(731) 925-3157

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Bedford, Lincoln, Marshall and Rutherford Co  
709-A East Lane St., Shelbyville, TN 37160  
(931) 685-5030

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Chester, McNairy and Hardeman Co  
P.O. Box 471, Selmer, TN 38375  
(731) 645-3531

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Henry, Obion and Weakley Co  
P.O. Box 226, Dresden, TN 38225  
(731) 364-3430

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Benton, Carroll and Gibson Co  
P.O. Box 785, Huntingdon, TN 38344  
(731) 986-9528

Giles, Maury and Lawrence Co  
57 Firetower Road, Lawrenceburg, TN 38464  
(931) 766-1413

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Lewis, Perry and Hickman Co  
P.O. Box 101, Centerville, TN 37033  
(931) 424-4009

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Decatur, Madison and Henderson Co  
P.O. Box 438, Lexington, TN 38351  
(731) 968-6676

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Shelby, Fayette and Haywood Co  
P.O. Box 202, Brownsville, TN 38012  
(731) 772-4592

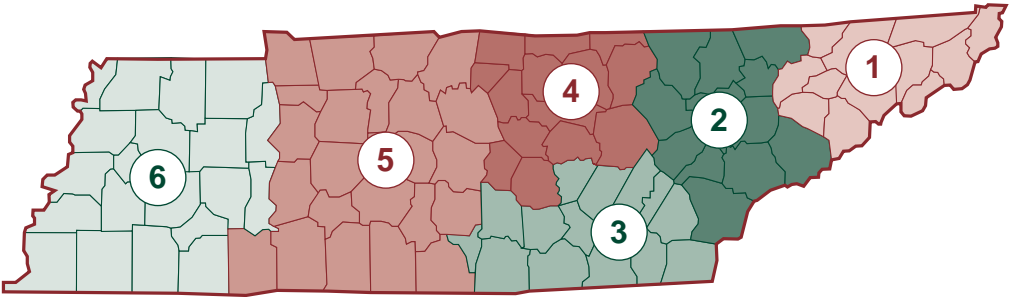
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Dyer, Lake, Tipton, Crockett and Lauderdale Co  
P.O. Box 624, Ripley, TN 38063  
(731) 635-4799



## DIVISION OF FORESTRY DISTRICT OFFICES

The Division of Forestry is divided into six Administrative Districts as shown on the map below:



### District One

P.O. Box 731, Greeneville, TN 37744  
Voice: (423) 636-8805 Fax: (423) 638-9096

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### District Two

P.O. Box 2666, Knoxville, TN 37901-2666  
Voice: (865) 594-6432 Fax: (865) 594-8907

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### District Three

P.O. Box 160, Hixson, TN 37343  
Voice: (423) 634-3091 Fax: (423) 634-6083

### District Four

390 South Lowe, Suite 10, Cookeville, TN  
38501-4702  
Voice: (931) 526-9502 Fax: (931) 526-2279

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### District Five

3497 Church Street, Burns, TN 37029  
Voice: (615) 797-3117 Fax: (615) 797-3113

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### District Six

P.O. Box 438, Lexington, TN 38351  
Voice: (731) 968-6676 Fax: (731) 968-5356





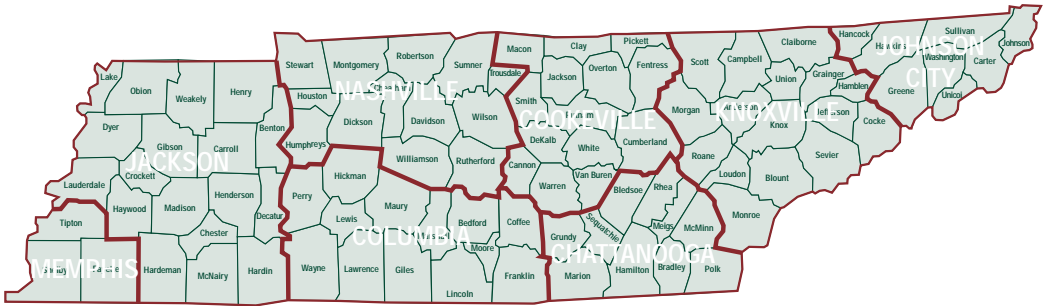
TENNESSEE DEPARTMENT OF ENVIRONMENT  
AND CONSERVATION  
ENVIRONMENTAL ASSISTANCE CENTER BOUNDARIES  
1-888-891-TDEC

**Jackson EAC (J)**  
362 Carriage House Drive  
Jackson, TN 38305-2222  
fax 731-661-6283  
**731-512-1300**

**Nashville EAC (N)**  
711 R.S. Gass Boulevard  
Nashville, TN 37243  
fax 615-687-7078  
**615-687-7000**

**Cookeville EAC (CK)**  
1221 South Willow Avenue  
Cookeville, TN 38506  
fax 931-432-6952  
**931-432-4015**

**Johnson City EAC (JC)**  
2305 Silverdale Road  
Johnson City, TN 37601-2162  
fax 423-854-5401  
**423-854-5400**



**Memphis EAC (M)**  
Suite E-645, Perimeter Park  
2510 Mount Moriah Road  
Memphis, TN 38115-1520  
fax 901-368-7979  
**901-368-7939**

**Columbia EAC (CL)**  
2484 Park Plus Drive  
Columbia, TN 38401  
fax 931-380-3397  
**931-380-3371**

**Chattanooga EAC (CH)**  
Suite 550 State Office Bldg.  
540 McCallie Avenue  
Chattanooga, TN 37402  
fax 423-634-6389  
**423-634-5745**

**Knoxville EAC (K)**  
Suite 220, State Plaza  
2700 Middlebrook Pike  
Knoxville, TN 37921  
fax 865-594-6105  
**865-594-6035**



## CONTACTS FOR ADDITIONAL INFORMATION

### FORESTRY AND/OR WILDLIFE MANAGEMENT

#### **University of Tennessee Department of Forestry Wildlife and Fisheries**

274 Ellington Plant Sciences Building  
Knoxville, TN 37901-4563  
865/974-7126  
[fwf.ag.utk.edu](http://fwf.ag.utk.edu)

#### **The University of Tennessee Agricultural Extension Service**

Forestry Wildlife and Fisheries  
Knoxville, TN 37901-4563  
865/974-7346  
[utextension.utk.edu](http://utextension.utk.edu)

#### **Tennessee Forestry Association**

2605 Elm Hill Pike, Suite G  
Nashville, TN 37214  
615/883-3832  
[tnforestry.com](http://tnforestry.com)

#### **Tennessee Wildlife Resources Agency**

Central Office  
Ellington Agricultural Center  
P.O. Box 40747  
Nashville, TN 37204  
615/781-0691  
[state.tn.us/twra](http://state.tn.us/twra)

West Tennessee (Region I)  
200 Lowell Thomas Drive  
Jackson, TN 38301  
731/423-5725  
Toll Free (in state) 1-800-372-3928

Middle Tennessee (Region II)  
Ellington Agricultural Center  
P.O. Box 41489  
Nashville, TN 37204  
615/781-6622  
Toll Free (in state) 1-800-624-7406

Cumberland Plateau (Region III)  
464 Industrial Blvd.  
Crossville, TN 38555  
931-484-9571  
Toll Free (in state) 1-800-262-6704

East Tennessee (Region IV)  
3030 Wildlife Way  
Morristown, TN 37814  
423/587-7037  
Toll Free (in state) 1-800-332-0900

## THREATENED AND ENDANGERED SPECIES

### **Tennessee Department of Environment and Conservation**

Division of Natural Heritage  
14th Floor, L&C Tower  
401 Church Street  
Nashville, TN 37243-0447  
615/532-0431

<http://www.state.tn.us/environment/nh/>

### **Tennessee Wildlife Resources Agency**

Central Office  
Non-game Biologist  
Ellington Agricultural Center  
P.O. Box 40747  
Nashville, TN 37204  
615/781-6619

<http://www.state.tn.us/twra/nongame.html>

### **U.S. Fish and Wildlife Service**

Cookeville Field Office  
446 Neal Street  
Cookeville, TN 38501  
931-528-6481

<http://cookeville.fws.gov/docs/endanger.html>