Mississippi's

BMPs

Best Management Practices for Forestry in Mississippi

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The *Best Management Practices Handbook* was developed by individuals representing a cross section of the forestry community, working through the Environmental Affairs and Wildlife Committee of the Mississippi Forestry Association.

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Foreword

The Water Quality Act of 1987 established as a national policy "that programs for the control of nonpoint sources of pollution be developed and implemented in an expeditious manner so as to enable the goals of the Act to be met through the control of both point and nonpoint sources of pollution." Section 319 of the Water Quality Act focuses on nonpoint sources of water pollution.

Nonpoint source pollution is any pollution in which the specific point of generation and exact point of entry into a watercourse cannot be defined. Origins of *nonpoint source pollution* include percolation, seepage and surface runoff from agricultural and silvicultural lands, and from construction, mining, and urban areas.

This handbook presents recommended standards, methods and specifications for the forest resource manager and forest landowner to follow in order to carry out silvicultural and forestry-related activities in compliance with Section 319 of the Water Quality Act. The term "*best management practice*" refers to a practice, or combination of practices, that is determined to be the most effective, practical means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals.

The *best management practices* discussed in this handbook address these categories:

Streamside Management Zones
Skid Trails and Haul Roads
Forest Harvesting
Site Preparation
Tree Planting
Artificial Revegetation of Disturbed Forest Sites

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Introduction

Mississippi has 19.7 million acres of forestland. It is estimated that some type of forest activity occurs on nearly 750,000 acres annually in the state. This represents approximately four percent of the state's forestland. Most streams originate or course through these forests and are sources for water supplies, prime recreation, and other water uses. Because of the importance of water resources, *silvicultural* practices should incorporate adequate measures to protect water quality from deteriorating. Anyone causing the pollution of or degradation to the state's waters is in violation of state law (Statutes 49-17-29 and 97-15-41, Miss. Code, 1972). The most practical approach for reducing the *nonpoint source pollution* from forestland activities is the use of best management practices, commonly referred to as BMPs.

Best management practices are non-regulated guidelines for *silvicultural* practices which, when properly applied, will control water pollution from nonpoint source pollutants and maintain *site productivity*. The BMPs presented in this handbook are best suited for Mississippi's climate, soils, and topography.

While most *best management practices* have a direct cost involved with implementation, many also have indirect economic returns beyond the water quality improvement goals for which they are primarily developed. Management decisions which include the use of BMPs often promote long-term benefits to the logger and landowner. For example, proper road and trail construction and drainage, in addition to fostering stream pollution abatement, extends the logging season by allowing an earlier passage of vehicles following periods of wet weather, thereby providing an economic benefit. In addition, vehicle maintenance costs associated with cleaning equipment are reduced as a direct result of properly locating roads and trails and providing adequate drainage. Many BMPs have similar tangible benefits which may not be readily seen.

From a forest production standpoint, the loss of one inch of topsoil due to faulty *site preparation* techniques has been estimated to reduce the site index by 5 to 10 feet, resulting in a decrease of volume production.

It is recommended that forest resource managers and others responsible for applying forestry practices use the "non-regulatory" *best management practices* discussed in this handbook. It will be necessary to monitor how well *best management practices* are being followed and the effectiveness of these practices in maintaining water quality. Presently, the Mississippi Forestry Commission monitors the compliance and use of *best management practices* and reports its findings to the Mississippi Department of Environmental Quality.

Why Should We Implement BMPs?

The BMPs in this handbook are intended to protect our environment in Mississippi - - our creeks, streams, fish, etc. As members of Mississippi's forestry community, we all spend time enjoying the outdoors. By following the BMPs in this handbook, we ensure that our children and future generations will also be able to enjoy Mississippi's natural beauty and benefit from its natural resources.

In addition to the environment, these BMPs protect peoples' land. For many Mississippians, their land is their biggest asset. By following BMPs, woods roads will be left in usable condition instead of washing out. Streams and ponds will continue to be suitable for watering cattle, fishing, and other uses that add value to the land. Wetlands provide critical habitat for fish and wildlife. Following BMP guidelines will help preserve essential functions of wetlands and provide for sustainable hunting, fishing and forestry. For loggers, following the BMPs will enhance their reputation in the community and increase demand for their services.

The total area of wetlands has declined greatly in the U.S. because of conversion to other land uses or by accidentally altering them until they no longer function as wetlands. Potential effects of forestry operations in wetlands (if BMPs are not adhered to) include excessive *erosion*, drainage alteration and stream obstruction.

More pragmatically, in wetland areas, following these BMPs will help you avoid the need for a wetlands permit. As discussed on page 23, the federal law which requires a permit for certain activities in wetlands contains an exception for forestry activities but the forestry exception is only available if the BMPs are being followed.

Finally, by following these BMPs, we avoid the possibility of more stringent requirements being imposed on a mandatory basis. At present, each state is allowed to establish its own BMPs which are tailored to that particular state's forestry techniques and terrain. Thus, these BMPs were tailored by members of Mississippi's forestry community, including foresters, loggers, and landowners, and for the particular circumstances here in Mississippi.

However, state and federal environmental agencies monitor our voluntary compliance with these BMPs. If those agencies determine that Mississippi's forestry community is not policing itself adequately, then we run the risk of those agencies establishing requirements that will be legally enforceable. Furthermore, if we fail to comply with the BMPs in this manual, we run the risk that any new agency-imposed requirements would be more burdensome and would be nationwide regulations that are not tailored to Mississippi's unique circumstances.

In short, complying with these BMPs will protect the environment, provide economic benefit, potentially avoid the need for a federal wetlands permit, and keep the regulation of Mississippi's forestry community in our own hands.

OTHER PROGRAM REQUIREMENTS

Implementation of BMPs is a requirement of most forest certification programs. For example, both the Sustainable Forestry Initiative standard and the Forest Stewardship Council standard require that participants meet or exceed BMPs and requirements of the federal Clean Water Act. The American Tree Farm System certification standard states that participants must adhere to all state BMPs and comply with all relevant ordinances.

Principles of Nonpoint Source Pollution Control Methods

Nonpoint source pollution is defined in Section 319 of the Water Quality Act of 1987 as "pollution caused by diffuse sources that are not regulated as point sources and normally associated with agricultural, *silvicultural* [emphasis added] and urban runoff, runoff from construction activities, etc. Such pollution results in human-made or human-induced alteration of the chemical, physical, biological and radiological integrity of the water."

The control of pollutants resulting from all forestry activities can be accomplished through adherence to six basic principles:

1. Do not allow surface water runoff from any type of soil disturbance to run directly into a watercourse.

2. Maintain the integrity of all streambeds and banks. When it is necessary to alter a stream's course for any reason, return the streambed and banks, as near as possible, to their original condition.

3. Do not leave debris of any type (logging or inorganic) in streambeds.

4. Do not spray chemicals directly into water or allow chemicals, *herbicides*, fertilizers or petroleum products to degrade surface or groundwater.

5. Leave *streamside management zones* along watercourses both to filter *sediment* from overland flow and to maintain the inherent, normal temperature of water in all streams and other bodies of water.

6. Provide for rapid revegetation of all denuded areas through natural processes supplemented by artificial revegetation where necessary.

> *It is the responsibility of the landowner and/or timber owner to ensure that pollution of state waters does not occur from forestry operations. The professional resource manager and the equipment operator working for a landowner also have an ethical responsibility to ensure that practices performed do not cause pollution under the Water Quality Act and state law. It is in the best interest of all parties involved with managing the forest resource to ensure compliance with water quality standards so as to maintain site quality and prohibit mandatory silvicultural practices.*

WATER QUALITY/FOREST MANAGEMENT PLANS

Good preharvest planning is recommended for water quality control. Soil *erosion* and *sedimentation* are forms of *nonpoint source pollution* that can be minimized by careful planning of road locations, logging and *harvesting* practices, *regeneration* operations and timber stand improvement activities. A forest management plan, complete with water quality objectives, provides the foresight needed to apply environmentally responsible forestry practices. State and federal agencies, consultants and private organizations offer assistance in developing forest management plans which meet the objective of protecting water quality.

To best implement best management practice guidelines prior to harvest, *site preparation* and other forestry activities, it is suggested that a forest management plan include the following information:

1. **Name:** Provide the name and address of the owner and, if applicable, the natural resource manager.
2. **Location:** Identify the property by legal description, city, town, highway numbers, name of *watershed*, receiving streams and major river basins. This information can be obtained from highway maps, topographic maps and aerial photographs.
3. **Type of ownership:** Describe the type of ownership (e.g., private, corporate; private, non-corporate; private, group, club or institution; or public).
4. **Prepared by:** The name and address of the person who prepared the plan.
5. **Map:** Include the total land area in the tract (e.g., open, cropland, woodland) and receiving waters.
6. **Description of property:** The total acreage of open land, cropland and woodland and a general description of land use should be given. This information may be obtained from farm plans, property deeds and aerial photographs. Detailed woodlands information should include:
    - General soil type and erodibility (obtain from local Natural Resources Conservation Service).
    - Range of percent slope (obtain from local Natural Resources Conservation Service).
    - Timber quality and age class (provided by a *registered forester* by on-site inspection).
    - Landowner's objectives (provided by the landowner).
    - Forestry practice recommendations (provided by a *registered forester*).
7. **Existing pollution problems:** Conduct an on-site inspection of all streams and other bodies of water to determine if any pollution problems exist, noting such evidence as excessive *sedimentation*, algae growth and fish kills.
8. **Best Management Practices:** Describe practices recommended for the tract. Include schedule of implementing recommended practices. Recommendations should be based on practices discussed in this handbook.

STREAMSIDE MANAGEMENT ZONES

Harvesting and *site preparation* activities may result in several types of *nonpoint source pollution* (NPSP), such as excessive *sediments*, *organic* debris, chemicals, nutrients, and an increase in average water temperature. *Streamside management zones* (SMZs) are vegetated areas adjacent to streams and watercourses that help protect them from these pollutants. This residual vegetation acts as a filter to trap sediments, chemicals, and nutrients before they reach the water. Some of this vegetation along *perennial streams* also provides the shade necessary to avoid adverse changes in water temperature. The proper use of SMZs depends upon stream type.

In Mississippi, streams are classified into two types: *perennial* and *intermittent. Drains* are considered separately. *Perennial* and *intermittent streams* need the use of SMZs, while drains do not.

PERENNIAL

A *perennial stream* is a watercourse that flows in a well-defined *channel* throughout most of the year under normal climatic conditions.

INTERMITTENT

An *intermittent stream* is 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 velocity sufficient to move soil material, *litter* and fine debris.

DRAIN

Drains (also referred to as draws, ephemeral streams, ephemeral areas or dry washes) have a well-defined *channel*. Generally not directly connected to the water table, ephemeral areas or gullies become a *drainage structure* connected to a stream in response to storm flow following heavy rains or when soils are saturated.

The stream type will dictate the amount of harvest allowed within the SMZ as well as the types of forestry activities. The assistance of the landowner, professional foresters or loggers familiar with the area will be beneficial in determining stream type. If there is a question about the type, treat it as a *perennial stream*. Regardless of whether it is a perennial or intermittent stream, several limitations must be adhered to:

GENERAL SMZ GUIDELINES

- Never use a stream *channel* as a *skid trail* or road.
- Remove *logging debris* from stream *channels*.
- Minimize the number of stream crossing points.
- Cross streams only at a right angle.
- Never block the flow of water through a stream *channel*.
- Avoid *rutting* through streams.
- Avoid high intensity fire in SMZ. All efforts should be made to keep high intensity site prep burns out of the SMZ.
- Minimize residual tree damage.
- Harvest of any stems on the edge of a stream *channel* must be accomplished in such a manner as to minimize impact to the stream bank.

All SMZs will extend from both stream banks to a distance determined by the *slope* of the land. The intent is to maintain sufficient overstory and understory crown cover to provide shade, maintain bank stability and protect water quality. Additional benefits include enhancing wildlife habitat, creating wildlife corridors and providing habitat diversity in harvested areas.

SMZ GUIDELINES FOR PERENNIAL STREAMS

Allowed	Not Allowed
▪ Select Harvest: Must leave 50% crown cover ▪ Individual stem treatment with *herbicides* to release desirable *regeneration*	▪ Roads (except perpendicular to stream crossings) ▪ *Excessive rutting* ▪ Damage to stream bank ▪ Any broadcast chemical application ▪ Any fertilizer application ▪ High intensity fire, such as those associated with site prep burns. ▪ *Mechanical site preparation* ▪ *Log decks* or landings ▪ Excessive residual tree damage

PERENNIAL STREAM SMZ WIDTH BY SLOPE

The *perennial stream* SMZ will have a minimum width of 30 feet extending from both sides of the stream measured from the banks. As the slope of the land adjacent to the stream increases, the SMZ width will increase.

Percent Slope	SMZ Width
0% - 5%	30 feet
6% - 20%	40 feet
21% - 40%	50 feet
Over 40%	60 feet

SMZ GUIDELINES FOR INTERMITTENT STREAMS

Intermittent streams will have a SMZ with a minimum width of 30 feet on both sides of the stream bank. Experience and judgment will dictate whether this width should be increased to protect water quality.

Allowed	Not Allowed
▪ *Regeneration* Harvest: Provided other vegetation and/or *ground cover* remains to protect the forest floor and the stream bank in a manner that will maintain water quality. ▪ Individual stem treatment with *herbicides* to release desirable *regeneration*.	▪ Roads (except perpendicular to stream crossings) ▪ *Log decks* or landings ▪ *Excessive rutting* ▪ Damage to stream bank ▪ High intensity fire, such as those associated with site prep burns. ▪ *Mechanical site preparation* ▪ Broadcast application of *herbicide* treatments

GUIDELINES FOR DRAINS

Drains do not require SMZs. However, there are several limitations that must be adhered to:

- Never use a *drain* as a *skid trail* or road.
- Minimize *logging debris* in well defined *drain channels.*
- Cross *drains* only at a right angle.
- Minimize the number of crossing points.
- Avoid *rutting.*
- Avoid blocking the flow of water.

GUIDELINES FOR LAKES AND PONDS

SMZ treatment for lakes and ponds will be determined by the identification of the outflow stream. If the outflow is perennial, treat it as a perennial waterbody. If the outflow is intermitten or ephemeral, treat it as an intermittent waterbody.

GUIDELINES FOR GULLIES

See **Drains/Ephemeral Areas**, page 5.

SKID TRAILS AND HAUL ROADS

Skid trails and *haul roads*, temporary or permanent, are constructed to provide access into forested lands. Temporary trails and roads are planned for short-term use (i.e., during a single operation or activity of normally up to 12 months duration). Permanent roads are constructed for longer periods of service. Specific guidelines for constructing *erosion* control structures are provided in **Upland - Erosion Control Methods**, pages 10 - 14.

SKID TRAILS

Skid trails are used for moving harvested materials from stump to landing. To avoid excessive and unnecessary soil *erosion*, provisions should be made for the adequate drainage of skid trails. A skid trail system, combined with properly located *log decks* and main *haul roads*, will aid in preventing soil *erosion* and stream *sedimentation*.

CONSTRUCTION

- Locate trails to serve the intended purpose while facilitating adequate control of surface water and *sedimentation*. Aerial photographs and maps (topographic) are helpful in designing road and trail networks. Locate landings first and design *skid trail* approach with low *grade*.
- Keep *skid trail* grades (steepness) below 15%, if possible.
- Break the *grade* occasionally and avoid long, steep grades.
- A cross-drain is needed immediately above extra steep pitches in the road and immediately before bank seepage spots.
- Install *water turnouts* at same spacing as on *haul roads*.
- Cross streams at a right angle.
- Locate trails where side drainage can be attained.
- Avoid potentially sensitive areas and problem soils, when possible.

MAINTENANCE

Maintenance of *skid trails* during logging consists chiefly of maintaining an effective drainage system. On completion of the logging operation, follow these steps:

- To protect trails after they are retired, proper water diversion structures are recommended.
- Discourage unnecessary traffic.
- Scatter brush and/or slash on *skid trails* to slow water movement and reduce *erosion*.
- At stream crossings, the streambed should be cleared of all slash and restored to natural shape, *grade* and stabilized.

HAUL ROADS

The following guidelines are suggested as simple, effective means of controlling *sedimentation* from areas of soil disturbance. More elaborate stabilization techniques are offered in technical guides prepared by the Natural Resources Conservation Service. These guides should be used when costs are warranted and additional uses for access roads are envisioned.

CONSTRUCTION

Locate roads to serve the intended purpose while facilitating adequate control of surface water and *sedimentation*. Aerial photographs and maps (topographic) are helpful in designing road and trail networks.

- Avoid potentially hazardous areas and problem soils, if possible.
- Locate roads where side drainage can be achieved.
- Topsoil, trees, stumps, roots, brush, weeds and other objectionable material should be removed from the area required for the roadway, including shoulders, ditches and side road approaches. Dispose of this material above the ordinary highwater mark.
- Use all suitable excavated material for the construction of the road when possible.
- Construct roads during drier periods of weather when possible.
- Allow road surface to settle before using.
- Avoid flat, no-*grade* roads. *Grade* should be limited to between 2% and 10%, if possible. Grades above 10% can be used for short distances. Avoid long steep grades to reduce the total number of *drainage structures* needed.
- Roads should be wide enough to enhance surface drying.
- Cuts and fills should have side slopes that are stable for the soil material.
- Establish bank stabilization in all stream crossing designs.

MAINTENANCE

- Maintain road surfaces as needed to limit the development of ruts.
- Discourage unnecessary traffic during periods of excessive moisture.
- Clean all *drainage structures* and ditches as needed.
- When a road is to be retired, *culverts* may be removed and replaced with *water bars*, dips, or ditches.
- To protect roads and ditches from *erosion* after they are retired, revegetation is recommended. Road closure by barriers, gates and other structures is advised.

EROSION CONTROL METHODS FOR TRAILS AND ROADS

The siltation load in surface water runoff from roads and trails is a primary contributor to *sedimentation* from logging activities. Several types of water control structures are suggested as effective means to reduce sedimentation arising from the transportation network. The specific type or mix of types most appropriate are dependent upon the soils, topography, equipment and objectives inherent to a particular operation.

SLASH DISPERSAL

Slash is the debris such as unmerchantable limbs and tree tops created in the process of a normal logging operation. Slash dispersal is probably the most immediate solution for prevention of soil movement on an active logging site. Wherever possible slash should be scattered back over exposed soil on skid trails and evenly dispersed across logging sets. Slash has also been used successfully to build water bars on skid trails.

REVEGETATION

Artificial revegetation using seed and or mulch can be used to protect the trails, roads and other exposed soil. See **Upland – Artificial Revegetation**, page 21.

SILT FENCES AND HAY BALES

Silt fences and hay bales are effective at reducing erosion and sedimentation. They can be used to stabilize exposed soil around stream crossings. They may also be used to stabilize embedded road ways and trails.

WATER BARS

A *water bar* is a mound of soil designed to divert runoff water away from the road. Runoff from these areas should not be channeled directly into the SMZ but, instead, allowed to run diffusely across it.

- *Water bars* should cross roads at an angle of approximately 30 degrees starting near the crest of the slope.
- Shallow *water bars* may be constructed prior to and during logging use and should be considered a temporary structure.
- Deep *water bars* are utilized when use of the road is finished and are considered a permanent structure.
- Avoid direct tie-in of turnouts and outfall of *water bars* to gullies.

Water Bar Spacing

Grade of Road *(percent)*	Approximate Distance *(feet)*
2	250
5	135
10	80
15	60
20	45
25	40
30	35
40	30

Water Turnouts

A *water turnout* is the extension of a drainage ditch into a vegetated area, providing for the dispersion and filtration of storm water runoff. Turnouts should be installed on any section of road or trail where water could accumulate. Runoff from these areas should not be channeled directly into the SMZ but, instead, allowed to run diffusely across it.

In general, *water turnouts* should be spaced at intervals no greater than:

- 200 feet apart on 2% to 5% grades,
- 100 feet apart on 6% to 9% grades and
- 75 feet apart on 10% or greater grades.

Outslopes

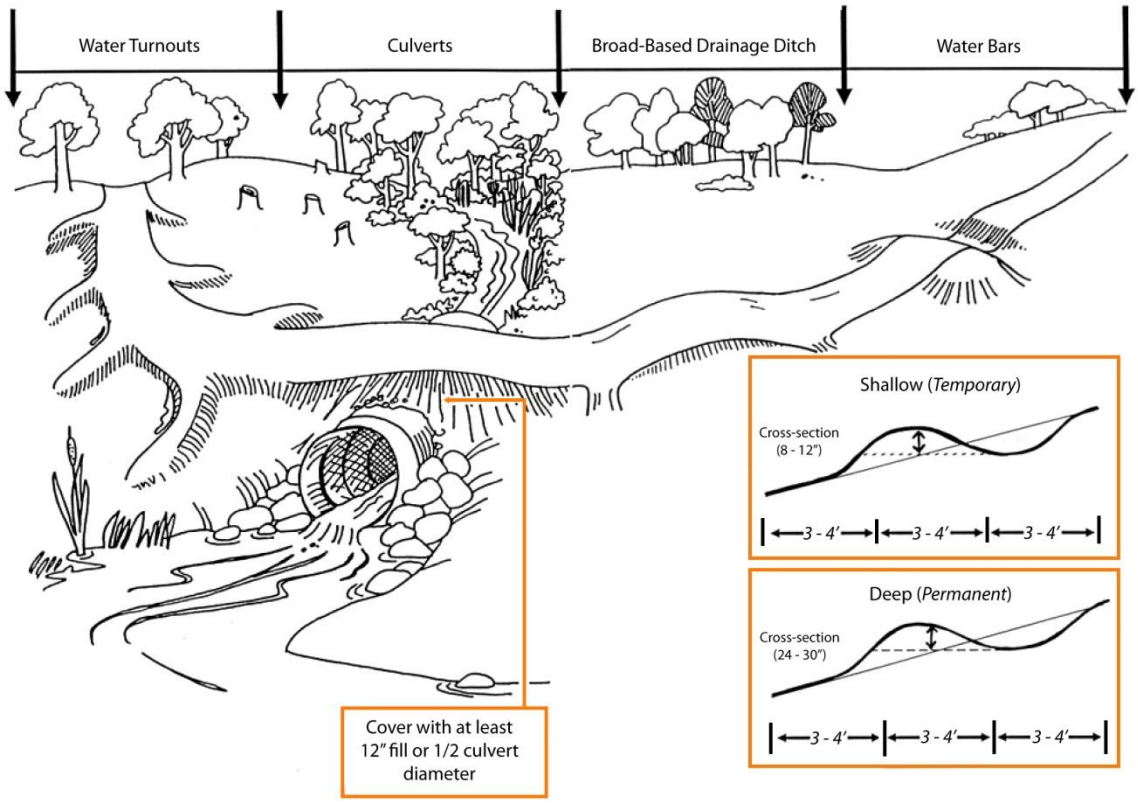
- Design *outslopes* to effectively move water away from the center of a road.
- *Outslope* the entire width of the road to reduce the number of *drainage structures* needed.
- A recommended slope is ¼" per foot of road width.
- Outsloping is not recommended for highly erodible soils.

Broad-Based Drainage Ditch

A *broad-based drainage ditch* is a carefully constructed *outslope* section of the road which serves as both a water catchment and drainage *channel*. This erosion control method requires an *outslope* of approximately 3% and a minimum width of 20 feet.

The approximate distance from one drainage ditch to the next is determined by the formula:

$$Distance\ (feet) = \frac{400}{\%\ slope} + 100$$



TEMPORARY STREAM CROSSING

The crossing of streams by roads, *skid trails*, or *firebreaks* should be avoided. If stream crossings are unavoidable, minimize the number of crossings, cross the stream by the least disruptive manner possible and control sediment. Protect water quality by maintaining the integrity of the stream bank, using fill materials that are easy to remove in the restoration process and minimizing the amount of fill dirt entering the stream.

Temporary crossings should be constructed using the following recommendations:

- Cross streams at a right angle using simple *culverts*, mats, log crossings or bridges.
- Approach streams at gentle slopes.
- If possible, use temporary bridges or portable logging mats (wood or steel dragline mats) rather than *culverts*.
- If temporary *culverts* are used and will be in place for an extended period, the fill should be stabilized using seed and mulch.
- Whenever possible, use logs or stems as fill over temporary *culverts* instead of fill dirt.
- Stabilize approaches during and after construction.
- Logs and stems may be used as temporary fill to cross streams.
- Crossing should not impede water flow and temporary crossing should be removed following harvest.
- When logging is complete, remove all temporary fill material and restore the *channel* to its original elevation.

PERMANENT STREAM CROSSING

Permanent stream crossings are used for "on-going" forestry operations where streams or drainages must be crossed by logging, site preparation, road maintenance and fire suppression equipment throughout the life of the stand. Permanent stream crossings include bridges, culverts and fords. These permanent crossings should be sized appropriately for the stream to minimize any long-term negative environmental impacts. During construction the integrity of the stream bed and slopes should be protected as much as possible and immediately stabilized using rock, seed and/or mulch. Aggregate or other suitable material should be used on approaches to ensure a stable road bed approach and reduce sediment in the stream. Permanent stream crossings will require frequent inspections to determine their functional and safe condition.

FORDS

A natural or paved stream crossing suitable for shallow streams with stable bottoms.

- Use *fords* if streambeds are solid and if the installation of bridges and *culverts* will accelerate soil movement.
- Enforce both approaches to a *ford* with gravel.
- Do not use *fords* in sensitive water areas.

BRIDGES

Bridges should be used over larger streams where heavy or long-term traffic is expected. This handbook does not attempt to make recommendations on bridge construction.

CULVERTS

A *culvert* is a metal or plastic pipe used to control the flow of surface water runoff and to allow for unobstructed flow of stream water. Place *culverts* in such a manner as to adequately drain the roadway while preventing soil *erosion*.

The *culvert* sizes in the following table are appropriate for both permanent and temporary crossings. In the majority of situations, the minimum *culvert* diameter recommended is 18 inches. However, a smaller diameter *culvert* may be used when minor drainage exists on flat topography.

GENERAL GUIDELINES FOR CULVERTS

- When using combinations of *culverts* to carry equivalent water flow, use *culverts* that are ¾ the diameter of the recommended diameter. For example:
    - Two 48" *culverts* may substitute for one 60" *culvert*;
    - Two 54" *culverts* may substitute for one 72" *culvert*.
- At road crossings of permanent streams, all structures should be placed to allow fish passage.
- All *culverts* should be installed at the proper level and be of sufficient size to carry anticipated water flow.
- Keep *culverts* clear of debris to allow unrestricted flow.

GENERAL GUIDELINES FOR CULVERTS (CONTINUED)

- Hollow log *culverts* are not recommended for permanent roads, but are acceptable on temporary roads if removed when the road is retired.
- To avoid ponding at the culvert inlet, the outlet end of the *culvert* should drop at the rate of ¼" per foot of *culvert* length.
- The lumber used in box *culverts* should be a minimum of 2 inches thick for both permanent and temporary roads.
- *Culverts* should be covered with a minimum of 12 inches of earth fill or ½ the *culvert* diameter, which ever is greater.
- The length of *culvert* should extend the full width of the roadbed, including side slopes. Or, if the *culverts* do not extend to the base of the side slopes, they should be protected with adequate headwalls or headers.
- *Riprap* and sediment traps should be installed as needed at *culverts* to prevent washing out.

CULVERT SIZE CHART

Acres Drained	Light Soils (Sands)			Medium Soils (Loams)			Heavy Soil (Clays)		
	Flat (%) 0-5	Mod (%) 5-15	Steep (%) 15+	Flat (%) 0-5	Mod (%) 5-15	Steep (%) 15+	Flat (%) 0-5	Mod (%) 5-15	Steep (%) 15+
	CULVERT DIAMETER IN INCHES								
5	18	18	18	18	18	21	21	21	24
10	18	18	18	21	24	27	27	27	36
20	18	18	18	24	27	36	36	36	42
30	18	18	18	27	30	36	36	42	48
40	18	18	18	27	36	42	42	48	
50	18	18	18	30	36	48	48	48	
75	18	21	21	36	42				
100	21	21	21	36	48				
150	21	24	24	42					
200	24	30	30	48					
250	27	30	30						
300	30	36	36						
350	30	36	42						
400	36	36	42						

Forest Harvesting

Forest *harvesting* is the cutting and removal of forest products from forestlands. *Harvesting* is conducted in order to obtain forest products, enhance the growth potential of trees left standing, establish new individual trees and stands by removing woody vegetation or enhance wildlife habitat and increase recreation opportunities. Activities involving the road and trail system, combined with other *harvesting*-related operations, can create water quality problems unless precautions are taken.

Preplanning the *harvesting* operation is essential in order to effectively minimize site degradation from *erosion* and water quality problems. The resource manager and equipment operator can sharply reduce the pollutant load resulting from forest *harvesting* activities by understanding each of the elements involved and applying common-sense, preventive measures.

Access Trails and Roads

- Follow the guidelines for access trails and roads. (See **Upland - Skid Trails and Haul Roads**, page 8.)
- Use procedures which will promote the quick healing of *skid trails*.
- Conduct skidder logging on the *contour* as much as possible.
- Skid uphill when skidding must be done against the *contour*.

Streamside Management Zones

- Maintain SMZ between harvest areas and watercourses. (See **Upland - Streamside Management Zones**, page 5.)

Logging Debris

- Avoid introducing *organic* debris into streams, which can alter the natural temperature and oxygen content of the water. Debris can also alter the natural flow, or movement, of the stream, which may lead to increased *sedimentation* in the stream.
- Remove tree tops and other *logging debris* from streams.

Equipment Maintenance

- Avoid spillage or discharge of petroleum products, antifreeze and other maintenance materials, especially near streams and other bodies of water.
- Drain equipment fluids into containers and dispose of according to label directions.
- Dispose of all empty containers in the same manner.
- Discharges or spills should be reported in accordance with the requirements of the Mississippi Department of Environmental Quality (MDEQ). Petroleum products spills over 25 gallons should be immediately reported to MDEQ at (601) 961-5171 or (800) 222-6362.

Landings and Concentration Yards

- Locate a landing or concentration yard on a site which will not present an *erosion* and subsequent siltation problem.
- Leave an adequate SMZ between landings and watercourses.

- Landings and yards should have a slight slope to allow drainage.
- Provide for adequate drainage on approach roads so that road drainage water does not enter the landing area, causing muddy wet conditions.
- Provide for stabilization of landings immediately following the completion of operations. (See **Upland - Artificial Revegetation of Disturbed Forest Sites**, page 21.)

PORTABLE SAWMILLS AND SAWDUST

- Locate portable sawmills on reasonably level sites.
- Deposit sawdust on level ground.
- Divert runoff water around a sawdust pile by ditching.
- Locate sawdust piles at least 300 feet from streams.

SITE PREPARATION

Site preparation is the treatment of an area to encourage natural seeding of desirable trees or to facilitate *artificial regeneration* of forest trees by planting or direct seeding. On areas recently harvested or areas growing undesirable vegetation, site preparation may be necessary prior to establishing a new stand of trees. A site can be prepared for *regeneration* through the use of *prescribed burning*, heavy equipment, chemicals or a combination of these or other acceptable methods.

Establishment or re-establishment of a stand of trees on cleared land will reduce *erosion* and protect or enhance water quality. Further protection can be achieved by the manner in which the site is prepared for such revegetation. Prompt revegetation following *site preparation* is desirable to effectively control *erosion*, *sedimentation* and nutrient leaching.

GENERAL GUIDELINES FOR SITE PREPARATION

- Avoid excessive soil compaction.
- Keep soil disturbance to a minimum.
- Minimize disturbance on slopes.
- Follow the *contour* as closely as possible when conducting *mechanical site preparation* (excluding *chopping*).
- Discharge water from site-prepared areas onto vegetated surfaces, wherever possible.
- Consider chemical site prep over mechanical site prep on highly erosive sites.
- Never broadcast chemicals in watercourses and *streamside management zones*.
- Never wash chemical containers or clean equipment in streams.
- Mix chemicals carefully and in an environmentally safe location and according to label instructions.
- Always choose the site prep method that creates the least soil disturbance, remains effective and safe and accomplishes *regeneration* goals.

SITE PREPARATION BURNING

The use of fire before planting or seeding will reduce logging residues, undesirable trees and competing vegetation. Most soil *erosion* problems arising from *prescribed burning* come from the plowed firelines installed with heavy equipment. However, firelines will cause very few water quality problems when properly installed. (Note: Firelines should not be confused with *firebreaks*, which are wide, grass-seeded lanes used to break up fuel loading and to provide access into and around wooded areas. *Firebreaks* should be managed as *skid trails*.)

- *Site Preparation burning, including fireline construction, should be kept out of SMZs.*
- Eliminate extremely hot prescribed burns. These may start active *erosion* since most of the organic cover is consumed by the fire. An extremely hot burn can also alter the soil's physical properties in a manner which decreases water infiltration, resulting in an increase of surface water runoff.

FIRELINE CONSTRUCTION FOR SITE PREPARATION

- Avoid constructing firelines at right angles to *contours*.
- Construct firelines around slopes at a *grade* of less than 10%, if possible.
- Avoid installing *diversion ditches* at the head of a *drain*.
- Do not construct a fireline down the slope of a shallow, natural *gully*.
- Firelines should not run directly into a SMZ. When anchoring a fireline to a SMZ, turn the line at the edge of the SMZ so that the plowed line parallels the zone.

MECHANICAL

Bulldozing, *shear-blading*, drum *chopping* and *disking* cause varying degrees of soil disturbance. A combination of treatments may be used on some sites. These treatments should be conducted in such a manner as to minimize soil displacement or compaction, minimize soil *erosion* on slopes and *sediment* movement into water and to prevent accumulation of debris in creek bottoms, ponds, streams or rivers.

Sheet *erosion* and subsequent *sedimentation* may be caused where the topsoil is removed by a straight-blade bulldozer. This practice does not create a major *erosion* problem on relatively level land, but *erosion* problems may develop on rolling or steep terrain.

- Avoid *mechanical site preparation* on steep slopes with extremely erodible soils.
- Do not push debris into a *natural drainage*.
- The practices of light dozing, root raking and *shear-blading* usually produce better results with fewer problems than straight-blading because less topsoil is disturbed.
- Construct *windrows* along the *contour*, keeping them short with numerous breaks.
- Drum choppers cause even fewer *erosion* problems because the topsoil and *litter* are less disturbed.
- Provide water outlets on furrowed areas at locations that will minimize movement of *sediment*.
- Where possible, discharge water onto vegetated surfaces.
- *Bedding* is used on poorly drained sites located on flat or nearly flat land. Soils must be of sufficient depth to provide a satisfactory root zone after *bedding*. On flat sites, the beds should run across the *contour* in a manner which will provide maximum surface drainage. (Note: *Bedding* may be used on slopes and terraces for topsoil consolidation and competition control. In these situations, beds should run along the *contour*.)
- One of the most effective measures for keeping *sediment* from site-prepared areas out of streams is the use of a SMZ. (See **Upland - Streamside Management Zones**, page 5.)

CHEMICAL

Chemical site preparation is an important alternative to *mechanical site preparation*. It may be used in conjunction with *prescribed burning* and, to some extent, with other site prep methods. Very little, if any, water quality problems arise when *herbicides* are used properly.

The use of *herbicides* should be carefully planned to prevent the contamination of streams and lakes, which may damage fish and other aquatic life.

- Choose an *herbicide* registered for intended uses and suitable for use on target species.
- *Herbicides* should also be suitable and safe for use with available methods of application.
- Always use *herbicides* in accordance with label instructions.
- Store *herbicides* where there is no danger of being spilled or released into the environment.
- Do not mix chemicals near springs, streams and lakes.
- Since wind and high temperatures increase the chance of *herbicide* drift, volatilization and pollution of water and atmosphere, make sure that atmospheric conditions are such that a maximum amount of chemical reaches target species, especially during aerial or spray applications.
- Never apply *herbicides* directly to water (except when the chemical is approved for application over water).
- Clean chemical application equipment away from streams and other water sources.
- Dispose of excess *herbicides* and containers in accordance with label instructions.

TREE PLANTING

Tree planting is the planting of forest tree seedlings, either by hand or machine. Tree planting may be undertaken solely to protect a *watershed*, or it may be conducted to establish a stand of trees for timber production, conserve soil and moisture, beautify an area, improve wildlife habitat or for a combination of objectives.

Planting sites include open fields, harvested timber areas, understocked woodlands, areas where less desirable tree species are to be replaced with desirable tree species and sites where *erosion* problems exist.

- Tree planting by hand causes little, if any, *erosion*.
- Tree planting by machine may temporarily cause *erosion*. The plow point and coulter blade on the planting machine creates a planting slit in which a seedling is placed. The slit is closed around the seedling by the planter's packing wheels, which may create a depression on each side of the slit. The depressions may *channel* surface water runoff, thus creating an *erosion* problem. To avoid ditch formation, machine planting should follow the *contour* of the site.

ARTIFICIAL REVEGETATION OF DISTURBED FOREST SITES

For the purpose of this handbook, artificial revegetation is defined as the process of re-establishing a vegetative cover on an erodible, disturbed forest site in order to stabilize the soil when natural revegetation process would be inadequate. These processes reduce *erosion* and runoff of *sediment* to watercourses. Revegetation recommendations should be developed by a natural resource professional.

Effective long-term *erosion* control is obtained with the establishment of a permanent vegetative cover. However, at times it may not be possible to establish a permanent vegetative cover due to limiting circumstances (e.g., time of year, availability of plant materials, etc.). In this case, the resource manager should establish a vegetative cover to provide temporary *erosion* protection to the disturbed site, with a permanent vegetative cover being established as soon as possible.

The following guidelines should be followed when establishing a vegetative cover.

PREPARATION FOR VEGETATIVE COVER

- Road surfaces and landings should be smoothed and shaped to permit the use of conventional equipment for seedbed preparation, seeding, mulch application and maintenance.
- *Culverts* should be maintained or replaced with *water bars* or ditches adequate to carry the runoff.

SEEDBED PREPARATION

- The top layer of soil should be loosened by raking, *disking* or other acceptable means before seeding.
- Chisel or loosen compacted areas.
- Spread available topsoil over unfavorable soil conditions.
- When conventional seeding is to be done, no preparation is required providing the soil material is loose (i.e., on a fresh *skid trail*) and has not been sealed by rainfall.
- On smooth, cut slopes or compacted trails the surface will require pitting, trenching or scarifying to provide a place for seed to lodge and germinate.
- Incorporate lime and/or fertilizer into the top 3 to 4 inches of soil as a part of seedbed preparation when practical.

SEEDING

- Inoculate legume seed with proper inoculant before planting.
- Apply seed uniformly by broadcasting with a cyclone seeder or close drilling.
- Normal depth for covering seed ranges from ¼ inch for ryegrass to 1 inch for small grain.
- When seed is applied with a hydraulic applicator, firming the soil is not necessary.

LIME AND FERTILIZER

- For the establishment of vegetation such as grasses and/or legumes, apply lime and fertilizer as needed for the species to be planted.

SELECTION OF SPECIES

Selecting the proper plant species suitable to the soil and seasonal conditions is vital to establishing an effective vegetative cover. Recommended plant species are offered in the following tables.

RECOMMENDED SPECIES FOR TEMPORARY COVER

Species	*Preferred Planting Dates*	*Seedling Rate*
Browntop Millet	May-July 15	25 lb. of seed/acre
Sorghum/Sudan grass	April-July	35 lb. of seed/acre
Ryegrass (Gulf or Marshall)	Sept.-Oct.	30 lb. of seed/acre
Oats (Florida 501 Bob)	Sept.-Oct.	4 bushels/acre
Wheat	Sept.-Oct.	2 bushels/acre
Rye (Vitagraze)	Sept.-Oct.	2 bushels/acre

RECOMMENDED SPECIES FOR PERMANENT COVER

Species	*Preferred Planting Dates*	*Seeding Rate*
Lespedeza (Sericea)	March-April	30 lb. seed/acre
Fescue (Ky-31)	Sept.-Nov.	20 lb. seed/acre
Bahia grass	Feb.-June or Sept.-Nov.	30 lb. seed/acre
Bermuda grass (hulled)	March-June	8 lb. seed/acre

WILDLIFE PLANTING RECOMMENDATIONS

Some landowners may wish to establish vegetation which will provide both ground cover and benefit to wildlife species. The following table lists those plants which may serve both purposes.

Species	*Preferred Planting Dates*	*Seeding Rate*
Browntop Millet	May - July 15	20 lb. seed/acre
Oats	Sept. - Oct.	4 bushels/acre
Wheat	Sept. - Oct.	2 bushels/acre
Winter Peas	Sept. - Oct.	30 lbs. seed/acre
Red Clover (Redland, Atlas)	Sept. - Oct. 15	8 lbs. seed/acre
White Clover (Regal, Osceola)	Sept. - Oct.	3 lbs. seed/acre

WETLAND REGULATORY REQUIREMENTS

Section 404 of the Clean Water Act (CWA) Amendments of 1977 establishes a program that regulates the discharge of dredged or fill material into waters of the U.S., including wetlands. This program requires a federal permit to be obtained for any activity that discharges clean fill or dredged material into waters of the United States, including certain wetlands. If an activity was not intended to discharge fill or dredged material, but does so anyway (for example, activity causing excessive *erosion* with the sediment being washed into a wetland), then the operator is in violation of Section 404. Normal forestry activities (for example: *bedding*, seeding, *harvesting* and minor drainage) are exempt from the requirement to obtain a Section 404 permit *provided* the activity:

1. Qualifies as "normal *silviculture*";
2. Is part of an "established" silvicultural operation;
3. Does not support the purpose of converting a water of the U.S. to a use to which it was not previously subject, for example from forestry to agriculture;
4. Follows the 15 mandatory *best management practices* (BMPs) for road construction (See **Wetlands – Skid Trails & Haul Roads**, page 28) and the 6 mandatory BMPs for *site preparation* (See **Wetland - Site Preparation,** page 34); and
5. Any discharge of dredge or fill material in waters of the U.S. is free from any toxic pollutants listed under Section 307 of the CWA.

Section 404 does exempt the construction or maintenance of forest roads as long as the 15 mandatory BMPs are followed and the flow, circulation patterns, chemical, biological and reach characteristics are not impaired.

The U.S. Army Corps of Engineers (COE) administers the day-to-day running of the Section 404 permit program. The Environmental Protection Agency (EPA) works with the COE to determine if an area is a wetland subject to Section 404 jurisdiction as well as determining mitigation. The EPA is responsible for developing and interpreting environmental criteria and has the authority to elevate and/or veto COE permit decisions. Both agencies define wetlands as:

> *Those areas that are inundated or saturated by surface or groundwater 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 other similar areas.*

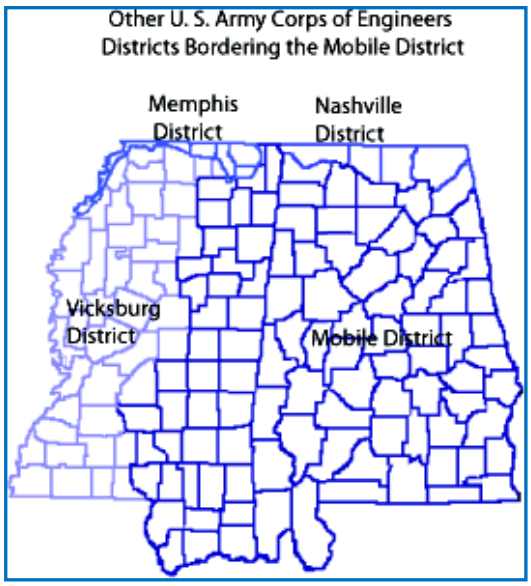
In order to determine whether an area meets the definition shown, both agencies look for three things (or criteria):

1. Hydrophytic vegetation – vegetation that grows, competes, reproduces and/or persists in anaerobic (no oxygen) conditions (i.e. under water).
2. Hydric soils – soils that are saturated long enough during the growing season for anaerobic conditions to develop in the upper part.
3. Wetland hydrology – inundated by water sufficient to support hydrophytic vegetation and develop hydric soils.

For examples of the above areas, see http://www.epa.gov/owow/wetlands/.

All three criteria must be present under normal circumstances for an area to be determined to be a jurisdictional wetland.

The biggest question that loggers and forest landowners want answered is, "do I need a permit for conducting forestry operations in a wetland?" The answer is usually no, *as long as* their operation meets the 5 criteria outlined previously. A Section 404 permit may be imposed on a forestry operation if the mandatory BMPs are not followed. A Section 404 permit would likely be required for forestry operations that cause a *permanent* change to the soil, hydrology or vegetation. Under certain circumstances, a Section 404 permit is required for *mechanical site preparation* in a wetland. To meet those circumstances generally requires extensive alteration so as to probably create a permanent change (as noted above) in order for mechanical equipment to operate. If there is a question as to whether an area is a jurisdictional wetland or whether a 404 permit may be required, contact the COE office that has jurisdiction over the area where the activity will take place



Memphis District – (901) 544-3471 or
http://www.mvm.usace.army.mil/regulatory/memphis.htm

Mobile District – (334) 690-2658 or http://www.sam.usace.army.mil/

Nashville District – (615) 369-7500 or http://www.orn.usace.army.mil/

Vicksburg District – (601) 631-5276 or http://www.mvk.usace.army.mil/

Mississippi Department of Environmental Quality / Water Quality Certification Branch – (601) 961-5171 or http://deq.state.ms.us/MDEQ.nsf/page/WQCB_Steam_Wetland Alteration03?OpenDocument

STREAMSIDE MANAGEMENT ZONES

The primary purpose of the SMZ should be to protect stream water quality and its function as an aquatic ecosystem.

The goals of wetland SMZs are as follows:

- Prevent movement of soil, fertilizer and *herbicide* from forest operation areas into the surface water system.
- Maintain water temperatures and water chemistry suitable for aquatic organisms.
- Maintain inputs of organic matter and coarse woody debris into water bodies.
- Maintain structural integrity of floodplain features (Figure 1).

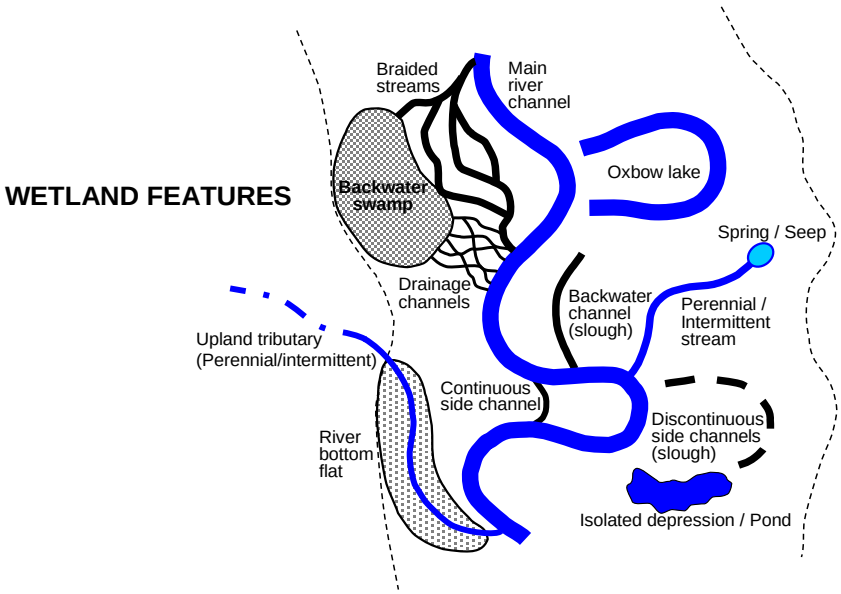


Figure 1. Schematics of floodplain physiographic features. (Modified from Mitsch and Gosselink, 1993 and Hodges, 1998)

WETLAND SMZ BEST MANAGEMENT PRACTICES

Maintain *streamside management zones* (SMZs) along all perennial and *intermittent streams*. SMZs with a minimum buffer width of 35 feet and a minimum of 50% crown cover should remain after harvest. Avoid disturbance or removal of ground cover or understory vegetation. Consideration should be given to leaving trees of various heights suitable for wildlife habitat.

- Keep site disturbance to a minimum by concentrating *skid trails* outside SMZs. Whenever possible use directional felling or cabling and winching to remove harvested timber within the SMZs. If conditions exist where *erosion* is anticipated, take steps to stabilize these areas.
- *Mechanical site preparation* should remain outside of the SMZ. Logging decks and staging areas should also remain outside of this area. Roads should be restricted to only those absolutely necessary for stream crossing.
- Hard surface crossings or *fords* can be used effectively and any approved substrate (i.e. rock, brick, concrete or logs may be used). Crossings should not impede water flow and temporary crossings should be removed following harvest.
- The broadcast application of pesticides or fertilizers is not a recommended practice within any SMZ. If use of *herbicide* is desired, an application should be by either injection or direct application and only with approved *herbicides* following label instructions.
- Logging operations should be conducted during seasonally dry periods of the year.
- Avoid cutting bank trees if removal may damage stream bank integrity.
- No chemicals should be applied to moving surface waters – however application of *herbicides* with an aquatic label may be used as directed on ponded surface waters and/or man made ponds and lakes.
- Consider suspending operations in wet weather and/or potential flooding conditions unless specialized wet weather equipment is available.
- Avoid residual tree damage.

BRAIDED STREAMS

Apply SMZ guidelines to each *channel* or run individually depending upon the flow regimes. In many cases, the main *channel* is a *perennial stream*, and minor runs are *intermittent streams*.

CANALS AND DITCHES

- Keep logging and *site preparation* debris out of *canals* and ditches.
- Minimize *canals* and ditch crossings and use bridges or *culverts* if appropriate.
- Exposed erodible soil should be stabilized as soon as practical.
- Avoid applying chemicals that are not labeled for aquatic applications directly to *canals* and ditches with standing or flowing water.
- Prevent *bedding* that channels surface runoff into *canals* and ditches.

SPRINGS/SEEPS

Treat accordingly as perennial and *intermittent streams*.

OXBOWS AND SLOUGHS

Oxbows and *sloughs* in a wetland do not need a SMZ if they are not connected to a perennial or intermittent stream.

DRAINS

Ephemeral Areas also known as *drains*, draws, ephemeral streams, or dry washes can collect and direct water during rain events into surface waters. Care should be taken to minimize these areas from becoming sources of pollutants. Silvicultural activities should:

- Minimize equipment traffic and soil disturbance, *litter* layer removal, and avoid high-intensity fire within ephemeral areas. These activities tend to increase the likelihood of inadvertently introducing pollutants to intermittent or *perennial streams*.
- Cover inadvertently exposed soils "subject to high risk for pollution" with *logging debris*, grass or mulch.
- Placement of *logging debris* or logging mats in traffic areas may be an appropriate pollutant control practice. Debris, mats and other soil protecting structures should not interfere with the natural flow of water.

WETLAND ROADS CONSTRUCTION AND MAINTENANCE PRACTICES

Road construction and maintenance can cause damage to forested wetlands if appropriate BMPs are not used. Potential damage includes increased *erosion* and sedimentation, altered drainage and flow patterns, habitat loss and degradation. Section 404 of the Clean Water Act (CWA) exempts the construction and maintenance of roads for forestry purposes from permit requirements, *provided* the roads are constructed and maintained in accordance with the 15 federally mandated BMPs. These 15 BMPs are *mandatory* for forestry operations in wetlands.

15 FEDERALLY MANDATED BMPS FOR ROADS

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 local topographic and climatic conditions.
2. All roads, temporary or 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.
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 to prevent *erosion* during and following construction.
5. Discharges of dredged or 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 intake.
12. The discharge shall not occur in areas of concentrated shellfish population.
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 in their entirety and the area restored to its original elevation.

FURTHER GUIDANCE ON ROAD PRACTICES

- Locate, design and construct forest roads according to pre-harvest planning.
- Use temporary roads in forested wetlands.
- Construct permanent roads only to serve large and frequently used areas, as approaches to watercourse crossings, or to provide access for long-term fire protection.
- Construct fill roads only when absolutely necessary for access since fill roads have the potential to restrict natural flow patterns.
- Provide adequate cross drainage to maintain the natural surface and subsurface flow of the wetland.
- Construct roads at natural ground level to minimize the potential to restrict flowing water.

IF RUTTING AND SOIL DISTURBANCE POSE A THREAT TO WATER QUALITY THEN:

- Where possible, minimize *rutting* and soil compaction, especially around the SMZ.
- Repair areas prior to leaving the tract.

TEMPORARY ROADS AND TRAILS

Roads and trails that are wet can be stabilized by using mats. There are a variety of mat types that are commonly used to cross wet areas.

OPTIONS	DESCRIPTION
Wood Mats	Individual cants strung together with cables to make a single layer crossing.
Wood planks and panels	Wood planks or panels are constructed using lumber planking to create a two-layered mat. Parallel runners are laid down on each side where the tires will pass.
Wood pallets	Wood pallet mats are sturdy and commercially available.
Bridge decking	Timber bridge decking can be used to cross wet areas.
Expanded metal grating	Relatively light and offers some traction.
PVC or HDPE Pipe	A PVC and HDPE pipe mat is constructed using at least 4 inch diameter pipes that are tightly connected using steel cables.
Tire Mats	Used tire sidewalls can be fastened together to form mats suitable for crossing wet areas.
Corduroy	This is a road made of small brush and logs cut from non-commercial trees on site and placed perpendicular to the direction of travel.
Pole Rails	Similar to a corduroy road, but poles are laid parallel to direction of travel.

Source: National Management Measures to Control Nonpoint Source Pollution from Forestry (EPA, April 2005)

STREAM CROSSINGS

Stream crossings should be avoided whenever possible. If it is necessary to cross a stream:

- Cross at straight stream sections
- Cross at narrow areas
- Cross at areas with stable stream banks or floodplains

There are three basic systems for crossing a stream: bridge, *culvert* and hard-surface crossing. Hard surface crossings or *fords* can be used effectively with any approved substrate (i.e., rock, brick, concrete or logs). Crossings should not impede water flow or cause downstream sedimentation. Temporary crossings should be removed following harvest

DRY – PERIOD INTERMITTENT CROSSINGS

- Follow the permanent crossing and approach guidelines.
- Minimize surface soil, stream bank, streambed and ground feature disturbance.
- If stream banks and streambeds have to be excavated for better trafficability, restore original *contours* immediately after completion of the job.
- If this type of crossing causes severe soil disturbance, restore the banks and use a temporary crossing bridge or *culvert*.

BRIDGE-MATS

When setting the bridge-mats in place, keep your equipment out of the stream *channel* - place the mats across the *channel* first, then adjust them as needed to insure a firm, stable crossing.

In some cases, brush and small vegetation may not have to be removed since the weight of the mat will hold it down. Do not leave a center gap between the travel lanes of the bridge-mats. Close this center gap between panels with another mat, strong boards, metal panels, de-limbed logs or something to keep dirt and debris from getting into the water.

Trees can be left standing as "bumper trees" to guide the dragged logs straight across the bridge-mats. These guide trees help keep the tops of the skidded logs or trees from dragging debris into the stream *channel*.

Occasionally inspect the mats while in use and clean off excess mud, soil or debris. The position of the mats may need re-adjusting as they are being used, if slippage occurs.

BRIDGE-MAT REMOVAL & BMPS

- Remove the mats carefully to minimize damage to the stream bank and *channels*
- Use BMP water diversions such as sediment traps, turnouts or other methods to control runoff from getting into the stream.

CULVERTS

Culverts may be used for either stream crossings or for cross drainage. If constructing a fill road through a wetland, space *culverts* at approximately 500 foot intervals to provide cross drainage for flood flows.

When placing in a stream *channel,* determine if the *culvert* will be temporary, or permanent:

- For temporary: place *culvert* directly on stream bottom
- For permanent: place *culvert* slightly below-grade in the stream bottom

Top of fill should be no less than 12" or ½ the pipe diameter (whichever is greater).

The length of the *culvert* should extend the full width of the roadbed, including side slopes. *Riprap* should be installed at the *culvert* outlet, as needed, to prevent scour.

When installing a *culvert* in a stream *channel* (perennial or intermittent) place the *culvert* so that it matches the slope of the *channel* bottom.

Culvert Sizing

Culverts placed in a stream *channel* should be sized to handle large flows. The larger the drainage area and the steeper the topography draining to the *culvert*, the larger the *culvert* needs to be. The minimum diameter for a *culvert* is 18 inches. (See *culvert* size chart in **Upland - Skid Trails & Haul Roads,** page 14.)

Removing Culverts

Try to re-create the natural shape of the stream bank and stream *channel* bottom as it was before the *culvert* was installed when removing *culverts*.

Stabilize the area to prevent accelerated *erosion*.

Road Bank Stabilization

Stabilization of banks along roads and streams will prevent bank *erosion* and failure, both of which may contribute considerable amounts of sediment to surface waters. Preventing *erosion* and slope failures can also alleviate the need for expensive road repairs that will be caused by these problems.

Revegetation and Road Retirement

- Seed areas as soon as possible after disturbance - this may even need to be done on a temporary basis
- Select a seed mixture appropriate for site soil and drainage ("conservation mix" is suitable for most areas)
- After seeding, mulch with hay or straw
- Stabilize unseeded areas with mulch

FOREST HARVESTING

Timber *harvesting* activities in wetland areas should be planned carefully in order to efficiently remove the tree crop while protecting both the forest productivity and ecological functions of the site. The *regeneration* system depends on the *harvesting* practices employed. Special care should be taken when *harvesting* near streams, lakes, sinkholes or other water bodies to follow the specific criteria provided in the *Streamside Management Zones* section of this manual. Depending on conditions, timber *harvesting* in these areas may be significantly limited. Also, special consideration should be given to maintaining the normal flood and sheet flow in wetlands areas.

ACCESS TRAILS AND ROADS

- Follow the guidelines for access trails and roads. (See **Wetland - Skid Trails and Haul Roads,** page 28.)
- When excessively wet *harvesting* conditions exist, low ground pressure equipment such as dual-tire skidders, tracked machines or special techniques such as "mat-logging" or "shovel-logging" should be employed where practical and economically feasible.
- Repair skidding damage which might lead to a water quality issue as much as practical, especially in the drainage system.
- Temporary roads should have cross drainage where necessary to maintain natural flow of water in the drainage pattern.

STREAMSIDE MANAGEMENT ZONES

- SMZ's should be maintained between harvested areas and watercourses. (See **Wetland - Streamside Management Zones,** page 25.)
- Machine operators should enter and exit the *Streamside Management Zone* when felling and bunching at a 90 degree angle as much as possible to minimize ground disturbance and damage to residual non-harvested vegetation within the SMZ.

LOGGING DEBRIS

- Every effort should be made to keep from introducing organic debris into water bodies. *Logging debris* should be removed from all water bodies as promptly as possible.
- Remove all trash, *litter* and other solid wastes from logging site and dispose of properly.

EQUIPMENT MAINTENANCE

- Avoid service of equipment that may cause spillage or discharge of petroleum products, antifreeze and other maintenance materials, especially near streams and other bodies of water.
- Drain equipment fluids into containers and dispose of according to label directions.
- Dispose of all empty containers in the same manner.
- Discharges or spills should be reported in accordance with the requirements of

the Mississippi Departments of Environmental Quality. Petroleum products spill over 25 gallons should be immediately reported to MDEQ – (601) 961-5171, (800) 222-6362.

Landing And Concentration Yards

- Leave an adequate SMZ between landings and watercourses.
- Use no more sets than necessary.
- Make sets no larger than necessary.
- Locate sets so skidding will have a minimal impact on the *natural drainage* pattern.
- Provide for stabilization of landings immediately following the completion of operations. (See **Upland - Artificial Revegetation of Disturbed Forest Sites,** page 21.)

River Loading Sites

River loading sites, i.e., located on the Mississippi River. When some properties along the Mississippi River, particularly islands, are harvested, logs are decked on the riverbank and picked up by a barging operation. Before starting any barge loading or un-loading operations you need to contact the Army Corps of Engineers and/or the local Levee Board to assess the need for a permit.

River loading sites are located in areas that have favorable water conditions for loading barges. They will also need to be located near main *haul roads* or in close proximity to the log job. These sites also need to be planned and constructed to have a minimum impact on water quality. The following suggestions should help to minimize any negative impacts on water quality associated with river loading sites.

- River loading sites should only be as large as needed for efficient unloading, storage and loading of logs or pulpwood.
- River loading sites should be constructed so that they slope away from the river and are adequately drained thereby, reducing *rutting* and sedimentation.
- Changing or draining of coolants, oils, fuels, etc. should be avoided in wetlands. If unavoidable all fluids must be captured and disposed of properly.
- Equipment leaks must be repaired immediately and spill kits must be at each river loading site.
- Trash must be removed and disposed of properly. River loading sites must be reshaped after use. This restoration should be accomplished by back dragging to smooth and fill the surface rather than pushing soil off the site.
- Ramps sloping towards the river offer the greatest opportunity for sedimentation. After use, these ramps must be blocked so that water does not drain down them and erode the bank. *Water bars*, hay bales or *erosion* cloth silt fences must be constructed or placed on the ramps to divert the flow of runoff water. (See **Upland - Erosion Control Methods**, page 10)
- Ramps and log storage areas must be seeded to establish ground cover above the normal high water level. (See **Upland - Artificial Revegetation**, page 22).

SITE PREPARATION

Site preparation in forested wetlands is a "normal silvicultural activity," but certain methods present challenges to land managers. None of the activities will require a permit unless it results in the conversion of a wetland to a non-wetland. The EPA and Army Corps of Engineers have determined that any **major** drainage activity in a jurisdictional wetland will require a permit, but minor drainage will not.

MECHANICAL

Mechanical site preparation offers more challenges and potential problems in wetland areas as compared to *chemical site preparation*. In 1995, the Army Corps of Engineers and EPA issued a memorandum on "Application of *Best Management Practices* to Mechanical Silvicultural Site Preparation Activities for the Establishment of Pine Plantations in the Southeast." Within that memo, specific forested wetland types are identified in which a Section 404 permit may be required for *mechanical site preparation* for pine establishment unless those areas no longer exhibit their unique distinguishing characteristics. These types which occur in Mississippi are as follows:

- *Permanently flooded* intermittently exposed and semi-permanently flooded wetlands: Examples include cypress-gum swamps, muck and peat swamps and cypress stands/domes.
- *Riverine bottomland hardwood wetlands*: Seasonally flooded or wetter bottomland hardwood sites within the first or second bottoms where overbank flooding has resulted in alluvial features such as natural levees. Soils are listed in NRCS surveys as poorly or very poorly drained. Bottomland hardwoods do not include sites in which greater than 25% of the canopy is pine.
- *Non-riverine forest wetlands*: Rare, high quality (undisturbed) wet forests, with mature vegetation, located on the Southeastern coastal plain, whose *hydrology* is dominated by high water tables. Two forest community types fall into this group:

  Wet hardwood forests: interstream flats comprising ten or more contiguous acres typically found on the margins of large peatland areas that are seasonally flooded or saturated by high water tables. Soils are listed as poorly drained mineral soils. Vegetation is dominated (greater than 50% of basal area) by mature swamp chestnut oak, cherrybark oak or laurel oak alone or in combination.

  Swamp forests: flats comprising five or more contiguous acres found on sites that are seasonally to frequently flooded or saturated by high water tables. Soils are listed as very poorly drained. Vegetation is dominated by mature bald cypress, pond cypress, swamp tupelo, water tupelo or Atlantic white cedar alone or in combination.

  Note: Sites dominated by red maple, sweetgum or loblolly pine alone or in combination are not considered to be of high quality, and therefore do not require a permit.

- *Tidal freshwater marshes*: *Wetlands* with dense herbaceous vegetation located on the margins of estuaries or drowned rivers and creeks regularly or irregularly flooded by freshwater.

Overall, *mechanical site preparation* activities do not require a Section 404 permit in **other** jurisdictional wetlands if the activity is conducted according to the following six federally mandated minimum BMPs:

- *Minimize soil disturbance.* Position shear-blades or rakes at or near the soil surface and *windrow* or 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.
- *Avoid soil compaction*. Conduct activities in such a manner as to avoid excessive soil compaction and maintain soil tilth.
- *Limit erosion and runoff*. Arrange *windrows* in such a manner as to limit *erosion*, overland flow and runoff.
- *Keep logging debris out of SMZs*. Prevent disposal or storage of logs or *logging debris* in *streamside management zones* to protect water quality.
- *Maintain natural contour 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.
- *Exercise water management*. Conduct activities with appropriate water management mechanisms to minimize off-site water quality impacts.

CHEMICAL

Herbicide use is an important tool for *site preparation* and may be a desirable activity in wetland areas. Forestland managers should adhere to the following guidelines when using *herbicides* in a wetland area:

- Read and follow all label instructions including approved applications, rates and restrictions. Applications should be made only by licensed personnel.
- Use only *herbicides* which have a "wetlands" or "aquatic" label approval.
- Follow SMZ restrictions for protection of bodies of surface water.

Using *herbicides* in a wetland area is an approved practice, but failure to adhere to these guidelines could result in serious problems.

ARTIFICIAL REGENERATION

The principal concern in *artificial regeneration* work is avoiding the conversion of a wetland to a non-wetland. Even though the presence of hydrophytic vegetation is a requirement in jurisdictional wetlands, planting tree seedlings or direct seeding efforts alone could not normally convert a wetland. While there are no specific prohibitions regarding *artificial regeneration* in wetlands, land managers are encouraged to consider species choice, planting method and competition control options.

SPECIES CHOICE

The safest approach is to plant species which naturally occur in wetlands. Any species can be planted as long as the planting (or *site preparation* which may be required to ensure survival and growth of the species) does not result in the immediate **or** gradual conversion of the wetland to a non-wetland.

PLANTING METHOD

Machine or hand planting may be used. Hand planting has no notable site impact, and machine planting is acceptable as long as it results in no negative impacts on *contour* or drainage of the site as may relate to conversion.

COMPETITION CONTROL (POST-PLANT)

Control of competing vegetation with the use of *herbicides* is acceptable if the *herbicide* has an appropriate label and is applied properly. Banded or spot applications would result in less site impact than broadcast applications, but either may be used if all BMPs and/or label restrictions regarding surface water are followed.

Mississippi's BMPs

BEST MANAGEMENT PRACTICES FOR FORESTRY IN MISSISSIPPI

GLOSSARY

Artificial regeneration - The establishment of a forest by planting seedlings or by seeding an area.

Basal area - A measure of the cross-sectional area taken up by trees at 4.5 feet above ground level.

Bedding - A site preparation technique, usually in wet areas, whereby a small ridge of soil is formed as an elevated planting or seedbed.

Best management practices (BMPs) - Forest management practices, developed pursuant to federal water quality legislation, to minimize or prevent nonpoint source water pollution. Often in more general usage referring to any good forest stewardship practices.

Braided stream - Stream systems with multiple interconnected channels, resembling the strands of a braid, with a low stream gradient. The divisions are typically caused by obstructions from sediment deposited by the stream.

Broad-based dip - A surface drainage structure designed to convey surface runoff off of a road while allowing vehicles to maintain normal speeds.

Buffer strip - A relatively undisturbed section of forest adjacent to an area requiring special attention or protection such as a stream, lake or road.

Canal - A man made perennial stream to be treated as such.

Channel - A natural stream which conveys surface runoff water within well-defined banks.

Chemical site preparation - The use of herbicides to control plant competition to prepare an area for the establishment of a future forest either by artificial or natural means.

Chopping - The flattening of vegetation remaining after harvest in order to concentrate it near the ground.

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

Culvert - A metal, concrete or plastic pipe through which water is carried.

Disking - Tilling soil to reduce competing vegetation.

Diversion ditch - A drainage depression or ditch built across the top of a slope to divert surface water from that slope.

Drainage structure - A man-made structure that facilitates the movement of water off an area.

Drain - Depressions commonly referred to as drains, draws, ephemeral streams, or dry washes that may or may not have a well defined channel. Generally not directly connected to the water table ephemeral areas become a drainage structure connected to a stream in response to storm flow following heavy rains, snowmelt or when soil is saturated.

Erosion - The detachment and transportation of soil particles.

Excessive rutting - The determination of excessive rutting is highly subjective and must be made by a *registered forester* or other qualified professional experienced in local logging operations, soil types and site conditions (see definition of *registered forester*). The determination must consider rutting extent and depth, soil type, slope, position on slope, management prescription and any other pertinent factors.

Firebreak -A wide, grass-seeded lane used to break up fuel loading and to provide access into and around the wooded areas.

Firelane - A cleared path wide enough to permit single-lane vehicular access into a remote area for the purpose of fire-fighting activities or prevention.

Ford - A natural or paved stream crossing suitable for shallow streams with stable bottoms.

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

Ground cover - Any living or nonliving organic material which may provide stabilization of the forest floor.

Gully – An eroded channel, hollow or narrow ravine generally caused by past land-use practices. They are typically V- or U-shaped channels that carry water only during and immediately following rainstorms or thawing events. Dry wash, draw, swale, arroyo, and gulch are other common names for gullies. Gullies may or may not be directly connected to ephemeral areas, intermittent or perennial streams.

Harvesting - The removal of merchantable tree crops from an area.

Haul road - primary road used for transporting harvested timber from a site.

Herbicide - Any chemical or mixture of chemicals intended to prevent the growth of or promote the removal of targeted trees, bushes and/or herbaceous vegetation.

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 velocity sufficient to move soil material, *litter* and fine debris. Aquatic insects are often difficult to find or are not present.

Lakes/Ponds/Water bodies - An area where water stands with relatively little or slow movement (ponds, lakes, bays).

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

Log deck - A place where logs or tree-length material is processed for loading and transporting.

Logging debris - The unutilized and generally unmarketable accumulation of woody material, such as limbs, tops and stumps, that remains after timber removal.

Mechanical site preparation - The cutting of all standing material with blades or choppers to prepare an area for the establishment of a future forest either by artificial or natural means. Associated mechanical practices include *disking* and *bedding*.

Mulching - Covering an area loosely with some material to hold soil in place and facilitate revegetation. Straw and bark are common mulches.

Natural drainage - A naturally occurring conduit for the flow of water.

Nonpoint source (NPS) pollution - Pollution which is (1) induced by natural processes, including precipitation, seepage, percolation and runoff; (2) not traceable to any discrete or identifiable facility; and (3) controllable through the utilization of wise management practices.

Outslope - To slope the road surface to cause drainage to flow toward the downhill side.

Organics - Particles of vegetation or biological material which can degrade water quality by decreasing dissolved oxygen and by releasing organic solutes during leaching.

Perennial stream - A watercourse that flows in a well defined channel throughout most of the year under normal climatic conditions. Aquatic insects are normally present and easily found.

Prescribed burning - The controlled use of fire to reduce or eliminate the unincorporated organic matter of the forest floor or low, undesirable vegetation.

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

Registered forester - A person who is registered and qualified to engage in professional forestry practices as determined by the Mississippi State Board of Registration for Foresters.

Riprap - A layer of rock used for stabilizing soil that is subject to erosion.

Rutting - Tracks in the soil resulting from the passage of heavy equipment.

Sediment and sedimentation - Eroded soil particles that are deposited downhill or downstream by surface runoff.

Shear-blading - The cutting of merchantable residual trees and stumps close to the ground after harvest.

Silviculture - The science and art of cultivating forests based on 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 productivity - An expression of an area's natural fertility or capacity to grow vegetation, especially trees.

Site preparation - A forest activity to remove unwanted vegetation and other material to cultivate or prepare the soil for reforestation.

Skid trail - A temporary, non-structural pathway over forest soil for dragging (skidding) felled trees or logs to a landing for processing.

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.

Spring/Seep - A place where groundwater flows slowly to the surface and often forms a pool; a small spring.

Streamside management zone (SMZ) - An area adjacent to the bank of a stream or body of open water where extra precaution is necessary to carry out forest practices in order to protect bank edges and water quality.

Water bar - A mound or ridge of soil formed across a road or trail for the purpose of deflecting water onto the adjacent area, usually into the forest *litter*.

Water turnout - The extension of an access road's drainage ditch into a vegetated area to provide dispersion and filtration of stormwater runoff.

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

Windrow - Logging debris and unmerchantable woody vegetation that has been piled in rows.

Wetland Types

Description of Wetland Types found in Mississippi

Wetland Type: Forested Wetlands

This type is usually located in the floodplain of major rivers and includes all of the types shown below except for the wet flats. Forested wetlands consist of bald cypress/tupelo gum swamps intermixed with bottomland hardwood forests. During flooding, the soils within the root system of the trees there become saturated and anaerobic (lacking oxygen), and trees are distributed according to their tolerances to flooding and anaerobic conditions. Swamps have standing water most of the time while bottomland hardwoods are flooded periodically. The species diversity of the floodplain develops in response to small relative changes in topography and soils and will follow parallel to the main stream. Mature forest trees in the depressions of sloughs and oxbows include cypress, blackgum, tupelo gum, ash and, on higher sites in the Mississippi Delta, some hackberry (sugarberry) and boxelder. Early succession tree species include cottonwood, willow and river birch.

Wetland Type: Blackwater River

This type is located in the *watershed* of major rivers. The flowing water is characterized by darkly colored water with low turbidity in well-defined channels. They are basically the headwaters of major tributaries that are located in the Coastal Plain. Sloughs and oxbow formations are well defined and interspersed all through the floodplain. Flooding occurs periodically during the spring under excessive rainfall conditions but recede rapidly. The sediment load of this wetland class is low. Examples would be the Noxubee, Strong River, Chunky, Bogue Chitto, Chickasawhay and the Buttahatchee.

Mature forest trees found in the depressions of sloughs and oxbows along blackwater rivers include cypress, tupelo, swamp blackgum and ash, with lower sites occupied by overcup oak and water hickory. The higher terraces and ridges in this system will also support cherrybark oak, Nuttall oak, red maple and Sweetgum with occasional pine (Loblolly or Spruce). Successional pioneer tree species include willow, red maple and sweetgum.

Wetland Type: Branch Bottom

This wetland situation is generally near headwaters and on major watershed floodplains. It, as in other major types, has characteristic small sloughs and oxbows along the main channel. They are dominated by constant seepage or spring-fed systems with minor flooding during the wet seasons. The major forest canopy is a mixture resembling that of the major river floodplains with the exception of muck swamps. Mature forest trees include swamp blackgum and cypress near drainages, overcup oak, water hickory, sweetbay and red maple. On the slightly higher sites, species can include sweetgum, slash and spruce pine, water and willow oak, laurel oak, swamp chestnut oak and green ash. Forest productivity is average compared to other similar types.

Wetland Type: Cypress/Tupelo Swamp

These sites occur in a linear sequence of depressions parallel in most instances to a major drainage. The soils are poorly drained wetland soils that parallel the stream course.

There are large areas that are classified as this type that occur on all drainages that flow into black water rivers. Examples of this type can be found along the Pearl and Pascagoula Rivers. This site is predominantly cypress with a mixture of swamp tupelo, blackgum, sweetbay and redbay. The successional pioneer species are usually willow and red maple.

WETLAND TYPE: MUCK SWAMP

(Includes: Backwater, Slough and Oxbow)

This type consists of areas that adjoin drainages near the major watersheds. This wetland type is characterized by slow moving or standing surface water even during periods of extended drought. They are particularly evident along the coastal counties as major streams such as the Pascagoula and the Pearl River get closer to their exit point into the Gulf. Muck swamps occur in the backwater areas along these drainages and in some areas along the Mississippi and Pascagoula Rivers. This site consists of soils having high organic content and supports mature forest stands similar to that of a blackwater river swamp. The major species include swamp blackgum, cypress, water tupelo, sweetbay and redbay. The higher areas or ridges, as they are sometimes called, have red maple, sweetgum, magnolia and yucca plants.

WETLAND TYPE: WET HAMMOCK (WET FLATS)

A hammock is a wetland formed where the soil is soggy, strongly acidic and low in nutrients such as nitrogen, phosphorus and calcium. These wetland areas usually lie between streams within a large floodplain. High water tables exist in this wetland type. It is usually standing water with some flow during wet seasons. They are commonly referred to as upland flats in the Coastal Flatwoods. Hammocks are found in pine savannahs in the coastal areas. The major species that occur in these wet hammocks are usually evergreens such as laurel oak. Green ash, sweetgum, sweetbay and swamp black gum are also found along with southern magnolias, red maple and willow oak on the better drained sites. Typical pioneer species include willow, gum and maple.

Other Resources

Water Quality Sources (Federal & State)

Water quality criteria for intrastate, interstate and coastal waters:
http://www.deq.state.ms.us/newweb/MDEQRegulations.nsf/RN/WPC-2

EPA water quality standards:
http://www.epa.gov/waterscience/standards/laws.htm#laws
http://www.deq.state.ms.us/MDEQ.nsf/page/WMB_Water_Quality_Standards?OpenDocument

Public water system intakes:
http://www.deq.state.ms.us/MDEQ.nsf/pdf/GPB_MSSourceWaterAssessmentProgram/$File/msswapp.pdf#page=21?OpenElement

Wild scenic/recreational rivers and TMDL:
http://www.nps.gov/rivers/wsr-black-creek.html
http://www.deq.state.ms.us/MDEQ.nsf/page/WMB_Water_Quality_Standards?OpenDocument

Threatened and Endangered Species

US Fish and Wildlife Service, ph: (601) 965-4900: http://www.fws.gov/southeast/jackson

General Forestry Questions and Management Plans

Mississippi Forestry Commission: http://www.mfc.state.ms.us

Federal Website on Natural Resources

Natural Resources Conservation Service: http://www.nrcs.usda.gov
Farm Service Agency: http://www.fs.usda.gov

Best Management Practices
for Forestry in Mississippi

NOTES

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