A seep, also called a spring seep or just a spring, is a permanent or intermittent discharge of water that emerges from the ground and flows across the soil surface without defined bed and banks. The limits of the seep are demarked by the extent of surface water, water-stained leaves, or other signs of hydrology. Avoid soil and leaf litter disturbance within the known area of the surface water. Limit harvest activity to dry or frozen conditions, when possible.

Intermittent streams have definable beds and banks, but water does not flow through the channel all of the time. Crossing an intermittent stream requires a permit. In contrast, ephemeral streams only occasionally have water flowing and do not typically have defined beds and banks. Use of motorized equipment should be limited near the streams and forest floor disturbance should be minimized. Avoid these areas when laying out skid trails and remove felled tree tops. It is strongly encouraged that skid trails, roads, site-preparation, and other soil-disturbing activities be minimized in the ephemeral streams to avoid erosion and sedimentation of stormwater runoff that will flow downstream into streams or other water bodies.

Fens and Bogs

Fens are wetlands that receive much of their water and nutrients from groundwater rich calcium and magnesium carbonates. They accumulate peat and have relatively high pH and nutrient levels. As a result, fens support a high diversity of grasses, wildflowers, and insects. The high water table, in combination with periodic disturbances such as beavers and seasonal fire, discourages growth of trees and shrubs within fens.

In contrast to fens, bogs are acidic, nutrient poor wetlands that receive most or all of their water from precipitation. They often contain rare, threatened or endangered plants or animals. They also do not tend to contain much in the way of commercially desirable trees.

Harvest activity immediately adjacent to fens or bogs may encounter weak soils that are highly susceptible to rutting. When timber harvesting occurs near fens or bogs, ground disturbance within the wetland area should be avoided. To prevent sedimentation or excessive nutrient delivery into a fen or bog, timber harvests should be avoided along slopes immediately above and leading into a fen or bog.

6. FOREST ROADS

Forest roads are that part of a forest land road system, either temporary or permanent, designed and maintained for the transportation of timber products and often maintained and used for access for resource protection and recreation activities. They are usually minimum standard roads, i.e., single lane with turnouts, surfaced with locally available materials or just the underlying bare soil that is compacted and graded after the vegetative cover is removed. Commercially processed gravel underlain by geotextile is good for use in critical erosion areas. Properly laid, constructed and maintained forest roads provide safe operations over longer periods at desirable vehicle speed. Operating and maintenance costs, as well as sedimentation runoff, are reduced because of proper construction (this includes installation of BMPs), placement and regular maintenance.

Planning and Forest Road Placement

Use of Soil Surveys

When constructing new forest roads or upgrading old ones, knowing the soil types that exist where the road(s) will be placed can be essential to knowing how to construct the road itself to minimize soil erosion. Most of the counties in Michigan have completed soil surveys.

Contact the local Conservation District, Natural Resource Conservation Service, or the County Extension Office for information about obtaining or using a soil survey. The description of a particular soil covers the nature and limitations of the soils, erosion hazard, rock outcrops, construction, and engineering properties of each soil series. Please note that these surveys are general guides and actual soil conditions should be checked in the field.

Other Factors in Road Placement

Reconnaissance of the property generally should be done before constructing a road or roads. This consists of looking at the property with a road plan in mind and developing an idea of where roads should or should not be built. Consider the following points during road reconnaissance:

- Remember to acquire a Part 91 permit, if outside of the sale boundary.
- Terminal Points – Where is the system going to start and end? Where is the best access from public roads? Where are the landings going to be?
- Grades – Roads designed with a slope of 10% or less are usually the easiest to maintain. If any segments exceed 10%, they should not exceed 300 feet.
- Topography – Roads on moderate side hills are easiest to build and drain.
- Obstacles – Note springs, seeps, wetlands, poor drainage areas, ledges, and rocky areas. Design the road system to go around them. If one is encountered after work has begun, move the road away from it.
- Distance from streams – The goal is to avoid placing a road within the RMZ, unless it is for the purposes of crossing a stream.
- Stream crossings – Cross at a 90 degree angle, if possible; if not, follow the stream contour. Approach the stream at as gentle a slope as possible. Keep the number of crossings to a minimum.
- Avoid placing roads in valleys, if possible.
- Old roads – Consider using existing or abandoned roads or trails to lessen soil disturbance. However, if they are located in areas where road drainage is difficult or the potential for erosion or rutting is high, it is better to construct a new road to the construction specifications stated in this manual.
- Size and duration of a timber sale and the anticipated season of harvest.
- The location and potential impact on flood plains and wetlands.

When planning forest roads to the harvest area, sketch the tentative location of the roads, landings, major skid trails, and the approximate RMZs on the plan map. An enlarged topographical map of where forest harvesting is to occur may be helpful.

Planning on paper helps to pinpoint potential problems, to develop alternative routes, and to consider what erosion and sedimentation control measures are necessary. Have RMZs identified prior to road placement to prevent locating roads or major skid trails in these sensitive areas.

Reducing Water Volume and Velocity on the Forest Road System

The first priority for constructing a road system is to keep the road surface as free of water as possible. Surface water running over exposed soil builds up momentum, as the slope and distance increase. The running water picks up soil particles then transports them down hill, causing soil erosion. Road drainage is the single most important factor in keeping the road passable and in minimizing erosion and sedimentation.

Various structures for water control and erosion control are discussed in the section, *Water Control Devices and Forest Roads*. Construct roads on side hills for good cross-drainage, while avoiding seeps, springs, and swampy areas. If a stream, spring, or seep cannot be avoided, plan to use proper water control structures (see pages 26-30).

The landowner and the person planning the road system should walk the proposed route of the road system and decide on matters affecting the owner's objectives and construction costs, while striving to preserve water quality and wetlands.

Road Grades

A road grade of 2% to 10% is desirable. A hand level should be used to avoid problem areas and maintain the desired grade of the road. Grade and slope are expressed as the amount of vertical rise, divided by the horizontal distance traveled, multiplied by 100. Check the grade frequently with the hand level. A single stretch that is too steep or a flat area that will not drain may result in road erosion. Where the terrain is relatively flat, the person laying out the road should strive to maintain a minimum 2% slope to maintain adequate drainage of runoff. Also, roads in low topography areas should be crowned (as shown in Figure 4), to allow for water to drain off the road, to lessen the chance of rutting and ponding.

Where absolutely necessary, grades of 15% to 20% may be used for short distances, (i.e., less than 300 feet). Where a steep grade is necessary, at least 300 feet of road above and below should be less than 10% grade, to reduce the amount and velocity of water on the steep area. On those portions of the road with such steep grades, special surfacing such as 3 inches of gravel may be necessary to avoid erosion and rutting.

BMP Construction Specifications for Protection of Water Quality

According to Environmental Protection Agency (EPA) estimates (EPA, 1999), over 90% of the sediment entering forested streams comes from the forest road system. Therefore, the entire road system should be designed to the best standards possible before any road construction begins. This process may take more time, but the road system will be more efficient, less costly, and easier to maintain, and ensure minimum negative impact on water quality.

Study the area, noting the lay of the land. Pay particular attention to steep slopes, flat areas, streams, spring seeps, boulders, rock outcrops, and other potential obstacles. Roads built on south-facing slopes tend to stay drier than those on north-facing slopes. Be sure to look at these problem areas during the walk-through of the area.

- The key to constructing a good “pro-water quality” road system is to have the entire road system follow the contour of the land and keep road grades consistently between 2% to 10%.

- Construct roads to break or change grade frequently. This will result in less erosion than roads that have long, straight continuous gradients.

- Gradients up to 20% are permissible for distances up to 300 feet.

- On soils with severe erosion hazard (see Table 2), grade should be 8% or less. Grades up to 12% are acceptable, if the length of this section is less than 150 feet.

- Water diversion by cross drainage culverts (interception of surface water on the road, up slope from the top of steep slopes) is often needed to keep excess water off the steeper grades.

- Cross all water courses as close to a right angle to the stream as possible. Size structures so that stream flow is not impeded, and in keeping with good drainage practices.

- Roads approaching stream crossings should have reduced gradients to disperse surface water at least 50 feet from the watercourse.

- Roads should be located (with the exception of stream crossings) a minimum distance of 100 feet from a lake or stream. Stabilize stream bank approaches with rock or gravel.

- Outslope (see Figure 4) the entire width of the road where road gradients will permit.

- As a safety precaution, inslope the road toward the bank on sharp turns, road gradients of 15% or greater, and on clay and/or slippery soils (see Figure 4).

- Where roads are insloped (see Figure 4), cross drain runoff 25 feet up-grade of any short stretches of road where gradients exceed 10%.

- Avoid locating roads on level ground, along ravine bottoms, or on a flood plain where drainage away from the roadway is difficult to establish.

- In areas having little or no slope, road drainage is often a problem. Crown these sections of road (see Figure 4) to get the water off and away from the roadway.

- During wet conditions, apply a layer of geotextile fabric covered with 3 inch crushed rock or coarse aggregate at a depth of at least 3 inches (6 inches is optimal), at least 50 feet before reaching the highway.

- Provide a minimum essential width of 12 to 14 feet for a single track road. Increase width as necessary at curves and turnouts. Note that logging trucks used for transporting wood chips may need road widths greater than 14 feet to operate safely and properly. Consider if trimming along the road is necessary and appropriate.

- Road-bank cuts should be sloped and seeded to prevent erosion as necessary.

- Ensure good road drainage with properly constructed and spaced turnouts, broad-based dips, and cross-drainage culverts. Construct turnouts so waterflows are dispersed and will not cut channels across buffer zones.

- Install riprap or rock having a range of 3 to 12 inches in diameter, with a minimum length of 3 feet (MDOT, 2003) at the outlets of cross-drainage culverts to slow the velocity and diminish the erosive force of these channelized flows. Channelized flows coming from cross drainings are known to have enough output velocity and volume to transport sediment across an entire RMZ. Hence, the need for energy dissipating rock at a culvert outlet.

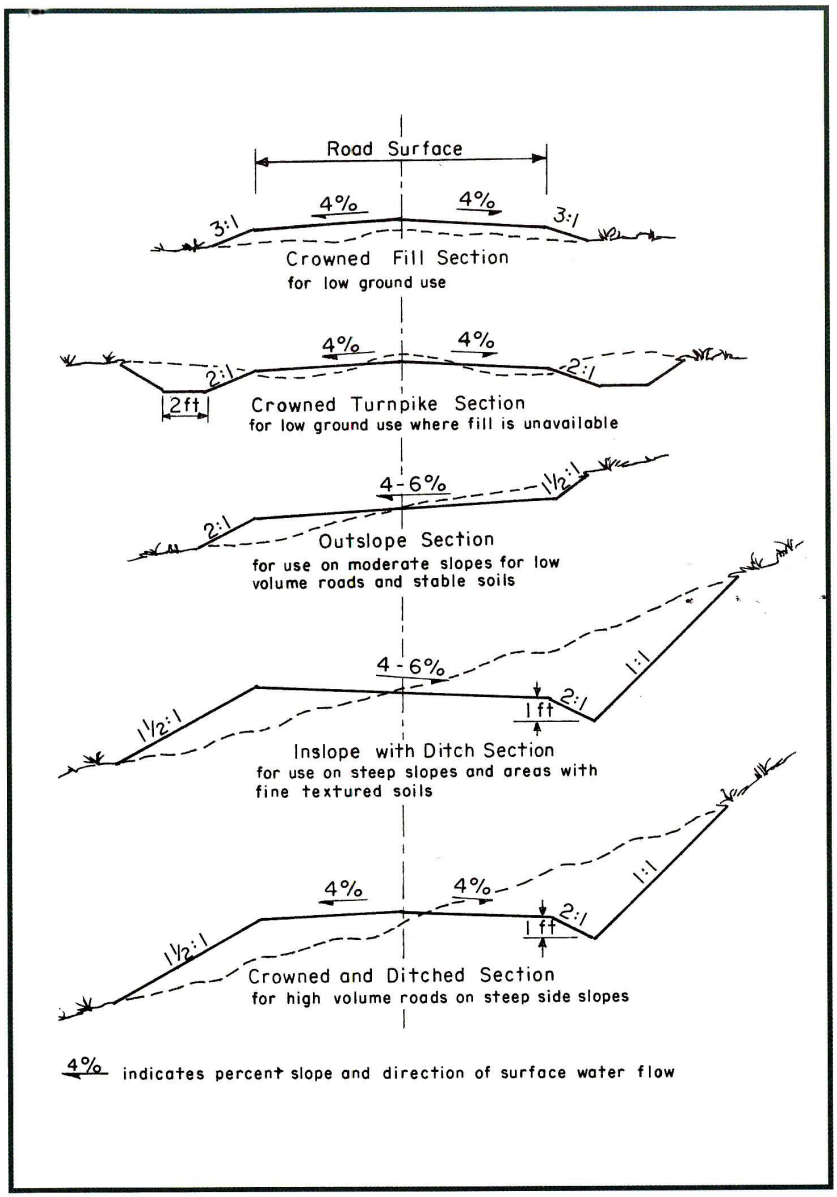

Figure 4. BMP Construction Road Techniques Based on Slope and Soils.
(Re-printed courtesy of the United States Forest Service)

Winter Roads

Winter roads are often used during the harvesting of forested wetland areas. They provide access during frozen ground conditions for timber harvesting and other timber management activities. Properly constructed, winter roads are recognized as an important component of forest management.

- Consider using culverts or bridges to cross definite drainages where winter roads are to be used for several years. Note: a DEQ permit is required for crossing streams and most drainage areas.

- Ice bridges can provide acceptable temporary access across streams during winter. Ice bridges are made by pushing and packing snow into streams and applying water to freeze the snow. Their use is limited to winter under continuous freezing conditions. A permit from DEQ is necessary before an ice bridge crossing can be built. Generally, ice bridges are best used for streams with low flow rates, thick ice, or dry channels during winter. Ice bridges might not be appropriate on large water bodies or areas prone to high spring flows. PVC bundles may be an alternative to facilitate water flow; make sure to anchor one corner of the bundle.

- Place winter roads on level terrain where practical.

- Based on the conditions of your DEQ permit, you may have to remove any culverts and bridges placed in the stream or other drainage way before spring thaw.

Road Management Measures on Active Sales for Permanent and Temporary Roads

- Avoid using roads for timber hauling or heavy traffic during wet or thaw periods on roads not designed and constructed for these conditions.
- Evaluate the future need for a road and close roads that will not be needed. Leave closed roads and drainage channels in a stable condition to withstand storms.
- Remove all drainage crossings such as cross-drainage culverts from temporary roads.
- Following completion of harvesting, close and stabilize temporary spur roads and seasonal roads to control and direct water away from the roadway. Remove all temporary stream crossings including any fill material.
- Inspect roads at regular intervals to determine the need for structural maintenance. Perform maintenance when conditions warrant, including cleaning and replacement of deteriorated structures and erosion and sedimentation control structures. This may include re-grading and seeding and mulching of roads no longer required for access. In certain cases, stabilize slopes or road fills where necessary to maintain structural integrity of the road.
- Perform maintenance activities such as dust abatement, so that chemical contaminants or pollutants are not introduced into surface waters, to the extent practical.
- Properly maintain permanent stream crossings and associated fills and approaches to reduce the likelihood that: (a) the stream overflow will divert onto roads, and (b) fill erosion will occur, if the drainage structures become obstructed.

- After significant rain events, look for possible problems and schedule corrective work as needed.
- Keep roadway and water control structures free of windfalls, logging debris and other obstructions.
- Ensure the free flow of water in the road drainage system, especially during logging operations.
- For permanent roads used during logging operations, periodically grade the road surface to reshape it so that it sheds water. Water should be able to freely flow off the road after grading.
- Fill in ruts and holes when they develop, as necessary

Road Closure and Retirement

To protect soil and water resources, access roads should be closed to vehicular traffic, unless the forest landowner has other management objectives. This can be done on a seasonal or semi-permanent basis. The reduction of traffic and associated maintenance work will mean a significant reduction in cost, as well as reduction in the source of erosion and sedimentation impacts on the water resource.

When several years between major treatment activities are anticipated, roads should be retired and closed. This involves using temporary soil stabilization materials and revegetating the road (see Appendix E for information regarding the proper methods to stabilize and revegetate roads and other areas having bare soil). Any road(s) no longer required for forest operation use or access should be closed and retired. If the newly or upgraded roads resulted in disturbing one or more acres of soil, or built within 500 feet of a water body, Part 91 requirements are in effect. These mandate that the road be revegetated, regardless of slope or erosive potential.

For those portions having a grade greater than 10%, periodic inspection, especially after rain events, is necessary to ensure erosion is not occurring. The following actions are recommended to retire a section of road:

- Smooth and shape all road and landing surfaces to aid in draining water off the surface of the road or landing.
- If cross drainage culverts are removed, replace them with water bars (see Figures 6 or 7). If properly-sized culverts are covered by more than 2 feet of fill and inlets and outlets are effectively stabilized, leave them in place, if it is less costly than removing them. However, cross drainage culverts left in place will require an established and committed inspection and maintenance schedule to prevent culvert blockage.
- Remove all temporary stream crossings, as required by law.
- Use native seed mixtures wherever possible (refer to Appendix E for specific directions) for erosion control and revegetating retired roads and landings.
- Whenever temporary soil stabilization methods are required to protect recently applied grass seed, install silt fence (see Figure 5), as required.
- The use of brush, slash or wood chips mulch over grass seed may be used, as long as it ensures that the site is permanently revegetated.

- Block the entrance of the closed road using metal structures, large boulders or large tree stumps.

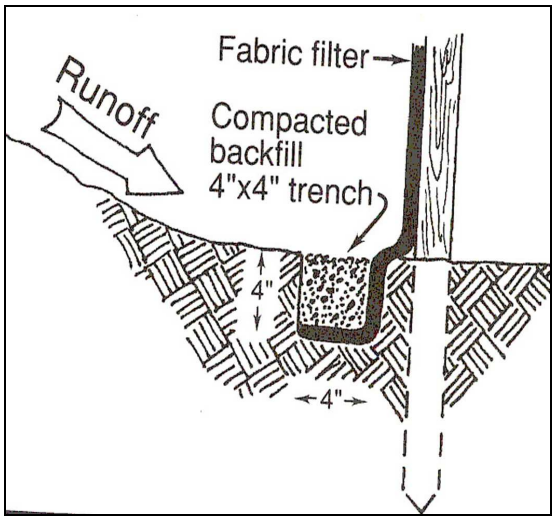

Figure 5. Proper Installation of a Silt Fence.

7. WATER DIVERSION DEVICES

Earth Berm Water Bars

Earth-berm water bars are narrow, earthen ridges built across roads or trails. They divert water off and away from roads or trails into vegetated areas before it causes erosion. When properly built, they prevent exposed soil from moving, protecting the area until grass vegetation is firmly established. Earth-berm water bars are recommended when forest management operations have ceased and the road is closed to further traffic.

- **Earth Berm Water Bar Installation Guidance.**
  - The first water bar should be placed at the top of the slope.
  - Where multiple water bars are required, properly space water bars according to Table 3.
  - As shown in Figure 6, the water bar should be placed at an angle of 30 to 45 degrees, relative to the road, to allow for runoff to drain from the inlet, through the trench, and into the adjacent forest floor or vegetation.
  - Dig a trench, 12 to 18 inches below the surface of the road or trail, and extend it beyond both sides of the road or trail to prevent runoff from bypassing the water bar.
  - The uphill end of the water bar should extend beyond the side ditch of the road and into an earth-berm to fully intercept any ditch flows.
  - The outflow end of the water bar is to be fully open and extended far enough beyond the edge of the road or trail to safely disperse runoff water onto the undisturbed forest floor.
  - After construction, seed and mulch the entire surface of the water bar to prevent erosion.
  - Earth berms and water bars are not meant to be used for active skid trails.