SECTION 1: SITE PREPARATION

Before construction begins, the construction manager, site superintendent or job foreman should meet with the design professionals and be supplied with a complete SWPPP or Erosion, Sediment and Stormwater Control Plan including a narrative description of the site and environmental conditions, detailed site map, construction/grading schedule, seeding schedule and maintenance/inspection schedule.

The construction manager, site superintendent or job foreman should review all federal, state and local regulations and understand completely the consequences of violations including but not limited to fines and imprisonment. Invite a local Missouri Department of Natural Resources representative to a preconstruction meeting if there are questions regarding the regulations. Invite all land disturbing contractors to the meeting.

Prior to excavation activities of any type, call 1-800-DIG-RITE (344-7483) to obtain utility locations.

Caution should be given to placing BMPs near streets. The drainage patterns in the vicinity of and around streets in new developments should be carefully studied so that the design or construction of BMPs will both meet local requirements and prevent any major flooding, sediment accumulation, traffic interruptions, o or rad damage during significant storm (design) events.

Post-construction practices today do not mean what they did in the 1970s when it was mostly about water quantity. Refer to Section 5 of this chapter for a complete discussion about post-construction measures that address both quantity and quality. The site manager or job foreman should also be aware of all planned post-construction measures. Many of today's state-of-the-practice post-construction features such as rain gardens, infiltration trenches and bioswales are incorporated into the initial site design. Their ultimate placement and function need to be considered throughout the construction phase in order to avoid roadblocks to implementation. See Section 5 for more detail.

For more information on environmental site design for the development plan and operation and maintenance considerations, see *Missouri Guide to Green Infrastructure: Integrating Water Quality into Municipal Stormwater Management 2011*.

Temporary Rock Construction Exit Pad

Figure 6.1 A temporary rock construction exit can reduce sediment and resulting safety hazards on public streets. This pad needs maintenance due to sediment filling the void spaces between the rocks making the rock exit pad ineffective. Source: ABC's of BMP's, LLC

Practice Description

A temporary rock construction exit is a stone base installed to provide an exit area where construction vehicles can drop the mud and caked soil from their tires to avoid transporting it onto public roads. The mud and dirt that ends up on the street is called "track out" and is the number one complaint associated with construction projects. The rock will jar and flex the tire treads so dirt and mud on the tires will become dislodged and collect in the voids of the rock exit pad. This device should be incorporated anywhere traffic will be leaving a construction site and moving directly onto a public road or other paved area.

The rock exit pad is often not effective by itself and requires a lot of maintenance. High-clay content soils may not adequately separate from the tires, and the rocks must be reconditioned as void space is filled with sediment. You may need to install additional practices, some of which are described below. Superior practices may be available in the construction industry, although the temporary rock construction exit pad is most commonly used.

Prior to the start of construction, temporary rock construction exit pads should be designed by a qualified professional. The site superintendant and field personnel should refer to plans and specifications throught the construction process.

The design professional should give consideration to the following:

- Limit the points of entrance and exit to the site.
- Designate combination or single purpose access points to the construction site, and require all employees, subcontractors and others to use them.
- Properly grade each construction entrance and exit to prevent runoff from leaving the construction site.
- Route runoff from a stabilized pad through a sediment-trapping device before discharge.
- Design the pad to support the heaviest vehicles and equipment that will use it.
- Avoid placing the exit pad in low areas where stormwater accumulates or discharges off-site.

Recommended Minimum Requirements

Aggregate Size

2- to 3-inch washed stone.

Pad Design

- Thickness: 6 inches minimum.
- Width: 12 feet minimum or full width of roadway, whichever is greater.
- Length: 50 feet minimum.

Signage

Clearly designate these areas to be used for exiting the construction site and make sure everyone involved with the project is aware that track out is not tolerated.

Wheel Wash (Optional)

Level the area with a minimum of 3 inches of washed stone. Remember if a wheel wash station is installed, all wash water must be collected and treated before it is discharged from the construction site. A simple sediment trap can be added next to the rock pad to collect the wash water and allow it to discharge over a check dam and into the road ditch. See additional information on wheel wash devices later in this section.

Geotextile Fabric

An underliner of woven geotextile (fabric) should be used under the rock to provide stability.

Construction

Avoid locating on steep slopes or at curves on public roads. If possible, locate where permanent roads will eventually be constructed. Limit the number of access roads to limit the inspection and maintenance of these devices and areas where sediment could be tracked onto public roads.

Site Preparation

Remove all vegetation and other unsuitable material from the foundation area; grade and crown for positive drainage. If wheel washing is indicated, provide a sediment trap adjacent to the rock pad to collect the discharged wash water for treatment before it is released off-site.

Grading

- If the slope towards the road exceeds 2 percent, construct a 6- to 8-inch high ridge with 3:1 side slopes across the foundation approximately 15 feet from the entrance to divert runoff away from the public road.
- Place geotextile filter fabric on the graded foundation to improve stability.

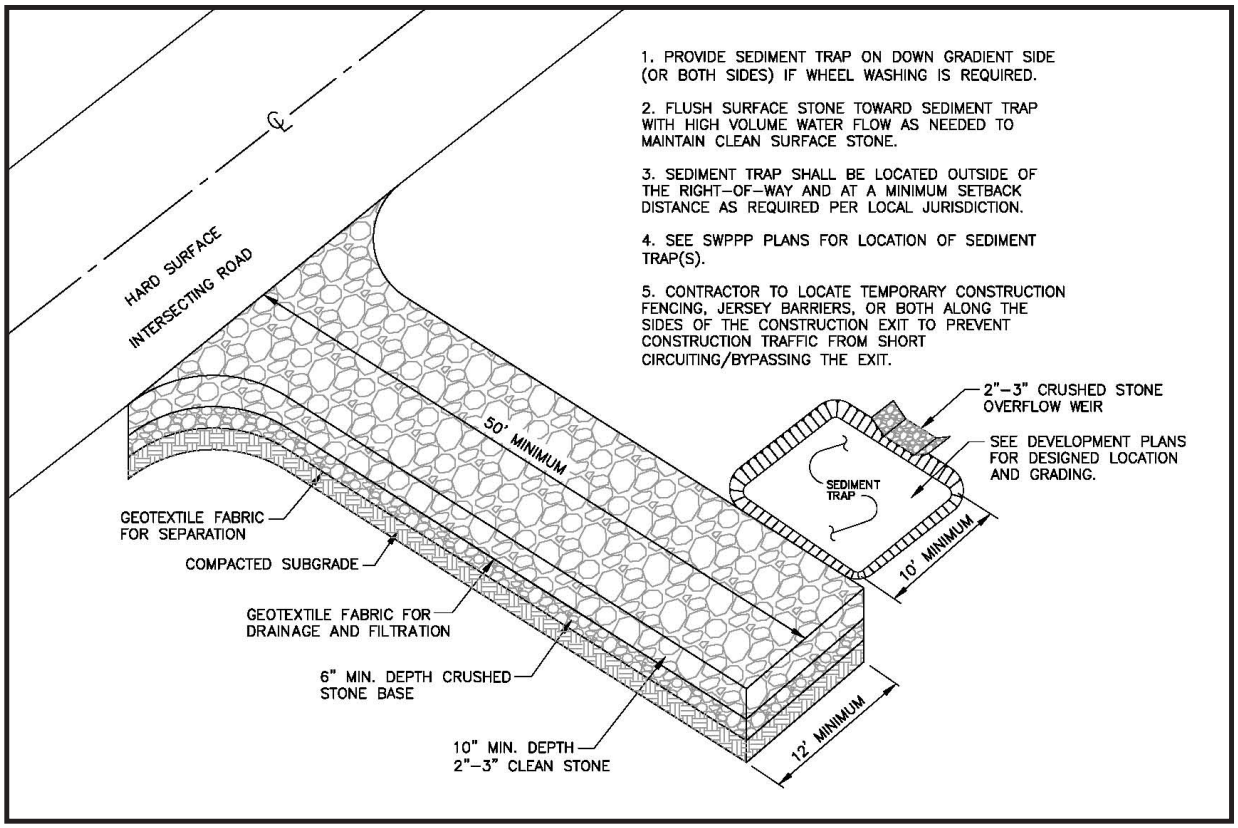

Figure 6.2 Typical Temporary Rock Construction Exit. Source; BFA Inc.

- Place stone to dimensions and grade shown on plans. Stone size should not be less than 2 inches or greater than 3 inches. Stones in the dimensions of 4- to 6-inches may become trapped between the dual tires on some construction vehicles and be transported off-site to later be thrown from the trucks tires and cause damage to vehicles or their drivers. Leave the surface smooth and sloped for drainage.
- Divert all surface runoff and drainage from the stone pad to a sediment trap or basin.

Maintenance, Inspection and Removal

- Inspect stone pad and sediment disposal areas weekly and after storm events or heavy use. When the voids between stones are filled with sediment or the pad becomes smooth and does not function to jar the truck and flex the rubber, it is not functioning properly and should be repaired. Add more rock or turn the existing stone over to move sediment below the stone so the stone pad will again have proper roughness and void spaces.
- Reshape pad as needed for drainage and runoff control.
- Topdress with clean 2- to 3-inch stone as needed.
- Immediately remove mud or sediment tracked or washed onto public road within 24 hours.
- Keep all temporary roadway ditches clear.
- Repair any broken road pavement immediately.
- Remove this temporary device and stabilize the site stabilized prior to filing *Form H: Request for Termination of a General Permit*, Form--MO 780-1409 (see Chapter One - Missouri Permit Requirements).

Common Problems and Solutions

Problem	Solution
Inadequate runoff control; sediment washes onto public road.	Install diversions or other runoff control measures.
Stone too small, pad too thin or geotextile fabric absent; results in ruts and muddy conditions as stone is pressed into soil.	Increase stone size or pad thickness, or add geotextile fabric. Stone should not be more than 4-inches in diameter, to avoid rocks being caught and thrown from dual tires.
Pad too short for heavy construction traffic.	Extend pad beyond the minimum 50-foot length as necessary.

Wheel Wash

Figure 6.3 Industrial wheel wash unit with self contained and recycled wash water. Source: *Innovative Equipment Solutions.*

Practice Description

A wheel wash device can consist of a range of tools from a simple compressor, hose and water source to a large scale industrial truck wash system. A wheel wash is designed to complement the rock construction exit pad to reduce the amount of sediment that might leave the construction site via construction vehicle traffic. Several portable wheel wash systems are available on the market today.

Recommended Minimum Requirements

While the installation of a wheel wash on the construction site will minimize mud tracking onto the roads, it is necessary to collect and treat the wash water to keep it from discharging off-site. Whatever type of wheel wash device is used at the construction site, a collection of the wash water is required in the form of a sediment trap or other such device. The water must be allowed to settle so the sediment is retained on-site and the treated water is allowed to discharge.

The size of the device and quantity of wash water will depend on the quantity and size of trucks treated. Some devices such as the one pictured above have self contained wash water collection systems that do not discharge the runoff.

Construction

Whether you install a portable wheel wash, or construct one on-site, you will need a water source and a collection system for the wash water. How the wheel wash is constructed and installed will depend on the type of system used. Make sure the installation of the system allows for a drip area between the device and public road so as little as possible of the wash water is transported to the public road to decrease wetting of the road. This is extremely important in cold weather when freezing is a possibility and the wash water could create hazardous conditions.

Maintenance, Inspection and Removal

- Capture all sediment from the wash water on-site and dispose of it in an appropriate manner.
- Clean out wash water capture device when sediment fills it to greater than 50 percent.
- Removal of this temporary device must be performed and the site stabilized prior to filing *Form H - Request for Termination of a General Permit*, Form--MO 780-1409 (see Chapter One-Missouri Permit Requirements).

Common Problems and Solutions

Problem	Solution
Sediment laden water drops onto the public road from the trucks exiting the construction site.	Increase the amount of washing to remove sediment from truck and increase the distance from wash area to road to provide a drip/dry pad for trucks. This will reduce water getting onto the public road.
Sediment-laden wash water from the trucks leaving the site drips onto the public road creating slick conditions.	Increase the washing of the vehicle on the site and allow the truck to drip-dry before driving onto the public street. Provide a sediment trap for wheel wash run-off as necessary.
Temperatures are near or below freezing creating ice from the wash water.	Discontinue the use of water to remove sediment from the construction vehicles before they enter the public street.

Rumble Plate

Figure 6.4 Prefabricated rumble plate, which produces a vibration of the tires and vehicle to dislodge dirt and mud form the construction equipment. Source: *Track out Control, LLC*

Practice Description

A rumble plate is a device that provides rough vibration to construction vehicles exiting the construction site. The vibration dislodges dirt and mud from the tires and undercarriage of the vehicles so sediment does not leave the construction site and drop onto a public road.
The rumble plates can be constructed of many types of material including, but not limited to, pipe or wood poles.

Recommended Minimum Requirements

Size the plate for maximum efficiency and allow for void space and sediment collection under the plate. Create a width so construction vehicles can not drive around and avoid the device.

Construction

Many rumble plate devices are prefabricated and shipped by the manufacture to the construction site. To construct your own device, remember the objects you construct it with need to be different diameters and spacing to create the vibration effect. The size and spacing of material should not be such as to cause harm or destruction to the vehicles driving over it.

The device should sit up on a frame with a void space below so the sediment drops from the trucks is trapped under the device. Then you can lift the device and scrape out the dropped sediment for easy clean out. Dispose of the sediment in an appropriate manner.

Maintenance, Inspection and Removal

- Clean sediment from under the device when it is close to filling the void area underneath. Dispose of the sediment on the construction site in an area that is stabilized and protected with a sediment control device.
- Remove the temporary device and stabilize the site stabilized prior to filing *Form H - Request for Termination of a General Permit*, Form--MO 780-1409 (see Chapter One-Missouri Permit Requirements) for termination of permit coverage.

Common Problems and Solutions

Problem	Solution
Device is ineffective.	Build the device longer and wider so construction vehicles can not exit without traveling over the device.
Device does not create a rough vibration.	Redesign the device with varied sizes of pipe and spaces between pipes.
After vehicles drive over the device, sediment is dropped onto the public street – device is not long enough to be effective or does not create a rough enough vibration.	Increase the length of device, clean out sediment from under the device and if necessary, redesign to increase vibration to vehicles driving over it.

Bamboo Mats

Figure 6.5 Bamboo mats placed at the exit of the construction site to contain dirt and mud falling from the construction vehicles before they exit the site. Source: *Brock White, LLC*

Practice Description

Bamboo mats are flexible fabric or mesh sewn together with pockets that hold bamboo reinforcing members. This alternative to rock construction exits is portable, reusable and can be joined with other mats to increase width and length as necessary. This device is not recommended for heavy truck traffic and should be considered for smaller construction projects only such as house lots or small construction sites. The bamboo can break down with excessive traffic from heavy construction equipment.

Recommended Minimum Requirements

Mats should be put together to meet design standards as well as state and local permit requirements. Mats can be effective until the reinforcing members break down. They are not designed for long periods of heavy use.

Construction

These mats are manufactured and shipped to the buyer to be installed on-site. They are reusable.

Maintenance, Inspection and Removal

- Inspect the mats weekly and after rain events.
- Clean sediment from mats and replace broken down mats as needed.
- Remove this temporary device and stabilze the site prior to filing *Form H - Request for Termination of a General Permit*, Form--MO 780-1409 of permit coverage (see Chapter One-Missouri Permit Requirements).

Common Problems and Solutions

Problem	Solution
Sediment fills area between reinforcing members.	Will need to be cleaned as necessary.
Reinforcing members may break down with extended heavy traffic.	Individual mats will need to be replaced if this occurs.

Streambank Setback

Figure 6.6: Homes too Close to Streambank Source: K. Grimes, SWCD, St. Charles County.

Practice Description

A streambank setback limits how close structures can be placed to the stream, and it restricts vegetation removal and grading of the riparian area along flowing waters. This practice is intended to protect the banks of natural streams from damage due to development, lessen the risk of flooding in developed areas and provide a buffer between the developed area and the stream. A properly maintained streambank setback will help maintain channel capacity and stability, reduce the sediment load in the channel and reduce the movement of pollutants into the stream. Setbacks help preserve natural channel meander and protect homes and other buildings from damage due to bank erosion and flooding.

The following recommended minimum requirements may not be adequate to protect water quality. Many communities have stream setback requirements up to 300 feet, depending on the quality of the stream to be protected. As a good example of a stream buffer ordinance, see the ordinance for the City of Kansas City or the City of Lenexa, Kansas at www.ci.lenexa.ks.us/LenexaCode/codetext.asp?section=004.001.015.

Streambank setbacks can also apply to areas adjacent to excavated open channels used for site drainage, drainage ways and watercourses that route runoff to streams. Consult your local government for ordinance requirements.

Recommended Minimum Requirements

Prior to the start of construction, the 100-year floodplain established by the Federal Emergency Management Agency and the streambank setback area should be shown on the design plan prepared by a registered design professional. Plans should be referred to by the site superintendent, job foreman and field personnel throughout the construction process. The streambank setback should be established according to the planned alignment and grade. Vegetation should be inventoried and flagged for retention.

Channel

Ensure that the channel is stable before determining the width of streambank setback.

Streambank Setback in Developed Areas

The greater of the following is recommended:

- A minimum of 50 feet from the top of the streambanks (larger setbacks will be needed where channels are downcutting, hydrology is shifting and in large drainage areas - if sufficient land is available, a 100-foot setback is encouraged to protect the stream from degradation and to protect property) beyond the 100-year floodplain.

Vegetation

If possible, preserve desirable natural vegetation within the setback area, especially on steep slopes. Establish vegetation on all areas without sufficient cover (see Vegetative Protection in the Streambank Protection section). Overall fish and wildlife habitat requirements and landscape character should be considered in determining the scope of streambank setback.

Street Setback

Streets in new developments should be constructed so that they remain usable during runoff from the design storm or according to local requirements.

Water Surface Elevation

A minimum of 1 foot below the ground floor of private dwellings and commercial buildings in a new development during the 100-year frequency, 24-hour duration storm.

Permits

Contact the Corps of Engineers and local authorities for permit requirements; permits may be needed if placing fill in wetlands or streams.

Construction

Site Preparation

- Follow all federal, state and local regulations for channel improvements required to increase stream capacity (due to development).
- Open channel cross sections should not be reduced in order to increase streambank setback. The use of levees within small watersheds is discouraged.
- Locate all underground utilities.

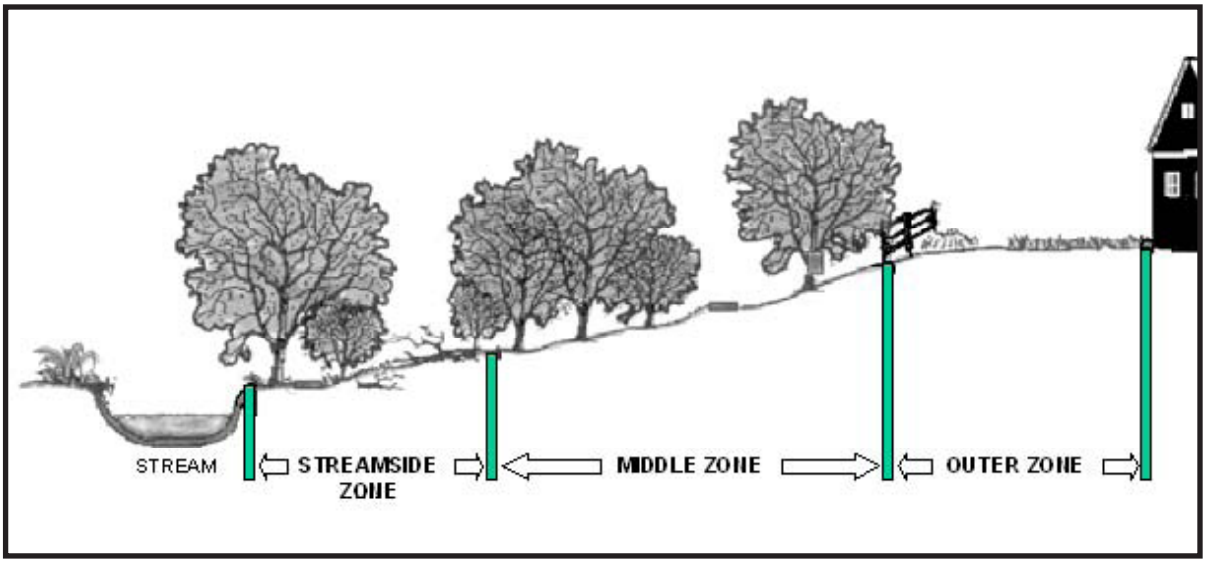

Figure 6.7 Three-Zone Stream Buffer System *Minnesota Stormwater Manual*. November 2005.
Source: Adapted from Schueler, 1995.

Natural Channels

- Natural channel side slopes should not be disturbed. When disturbance is necessary to develop a site, reestablish vegetation on channel side slopes as soon as possible after excavation or improvement.
- Consider the natural zones of a streambank community when placing vegetation. Use native plant materials for establishment and long term success. Lists of suitable species may be obtained from the Missouri Department of Conservation or NRCS.
  (See Streambank Protection.)
- Existing woody vegetation adjacent to the stream should not be disturbed.
- Leave any right-of-ways in the best condition feasible, consistent with the project purposes and adjacent land uses. A permit will be required to work in the right-of-way from the governing authority.
- Preserve or plant adapted trees to provide shade to prevent thermal pollution in the stream, help stabilize banks and provide wildlife habitat in those areas of perennial flow or where woody cover exists.

Erosion Control

- Minimize the size of all disturbed areas and stabilize as soon as each phase of construction is complete.
- Establish vegetation on all disturbed areas immediately after construction.
- The streambank setback area should not be used as a buffer strip during construction. This is important – if it is used as a sediment buffer, it could become contaminated with sediment and kill all the natural vegetation.
- Use temporary diversions to prevent lateral surface water from running onto the streambank setback area.
- After construction, if overland flow is required to go through the streambank setback area, velocities should be low (5 feet per second or less).

Safety

- At the completion of each day's work, move all construction equipment away from the streambank setback area in anticipation of flooding.
- Temporary stream crossings should be used by construction equipment to prevent destruction of the streambank setback areas.
- Construction materials and waste material should not be stored in the stream channel or streambank setback area.
- Provide temporary fencing and post warning signs until vegetation is established in areas that are disturbed.
- Provide site drainage.

Construction Verification

The alignment and width of the setback should be maintained during all construction activities. The final grades and elevations of the setback area should be checked to insure compliance with plans and specifications.

Maintenance, Inspection and Removal

- Check the streambank setback area after every storm event during the period of construction. In the setback area immediately adjacent to the stream (a minimum 10 foot width), reseed bare areas of soil greater than one square foot upon discovery and protect from soil erosion.
- Protect new plantings in the streambank setback area from livestock or wildlife.
- Mulch, spray (with an herbicide approved for aquatic use) or chop out undesirable vegetation periodically to prevent its growth.
- Keep inlets to side drainage structures open.
- Keep subsurface drain outlet pipes open and protected.
- Prohibit certain activities in the stream setback area, such as clearing and grading, drainage ditching, filling or dumping; and storage of motorized vehicles.
- Streambank setback vegetation maintenance after construction is the responsibility of the land owner. Make sure the landowner knows and understands their responsibility and the state and local requirements in their area.

Common Problems and Solutions

Problem	Solution
Variations in topography on site indicate setback or channel is inadequate or will not function as intended.	Changes in the plans may be needed.
Design specifications for seed variety, trees, mulch and fertilizer cannot be met.	Substitution may be required. Unapproved substitutions could result in additional flooding and erosion of the streambank.
Erosion of streambank setback; caused by disturbed land in setback area, inadequate vegetation or concentrated flow	Establish adequate vegetation in all areas or install measures to reduce flow concentrations.
Slumping failure or slides in streambank; caused by steep slopes.	Repair by excavating failed material and replacing with properly compacted fill. Consider reducing slope or installing streambank protection measures.
Reduction in stream capacity; caused by overgrowth of vegetation on the streambank.	Selectively cut overgrown vegetation.

Tree Protection

Practice Description

Tree protection preserves and protects trees during construction. Trees provide aesthetic and economic value, and aid in energy conservation, landscaping, air purification and erosion control. This practice applies to any construction site where desirable trees are present and need to be protected.

Trees can be damaged or killed by direct contact with construction equipment, compaction of the soil within the root zone of the tree, changes in the elevation of the water table due to site grading, and by construction chemicals and refuse. Although damage may be unseen, it can result in tree death within three or four years. Damage to the root zone is the leading factor in the unintentional destruction of trees.

Recommended Minimum Requirements

Prior to start of construction, desirable trees (including sensitive species) should be selected and marked for protection by a registered design professional. A grading plan that indicates the location of protected trees, utility trenches and other protected areas (e.g., floodplains, steep slopes, wetlands and streambanks) should be made available to field personnel. Areas for parking equipment should be designated away from the canopy (drip line) to protect the root zones of desired trees, shrubs, stream buffer vegetation and other protected areas. The root zone of plants is generally as broad as the drip line.

Temporary Fences

Placement

Around the dripline or tree canopy perimeter to restrict traffic, excavation, parking, storing materials and filling under the tree canopy. (For tree species sensitive to root damage, place the fence at the critical root radius to ensure tree's survival.)

Materials

Snow, board, plastic or cord fence.

Restricted Activities

Use temporary fence to restrict traffic, excavation, parking, storing materials and filling under the tree canopy (or at the critical root radius to ensure survival of sensitive species).

Permanent Drains

Install permanent drains in areas where site grading may be expected to cause water table saturation of the root zone (See Subsurface Drain).

Grading

Minimize cut and fill near trees by following the natural contours, and locating roadways, storage areas and parking pads away from desired tree stands.

Trenching

Minimize trenching near tree canopy perimeter and place several utilities in one trench when possible.

Up to 90 percent of trees' roots may be in the top 12 inches of soil. Typically, roots spread out from two to three times the width of the canopy or tree's branches.

Build a barrier at the dripline (or at the critical root radius for sensitive species) to prevent damage from soil compaction, cut and fill operations physical wounds.

To calculate the critical root radius: measure the tree's diameter in inches at breast height (4.5 feet above the ground), multiply that number by 1.5 feet. This will provide you with the critical root radius in feet.

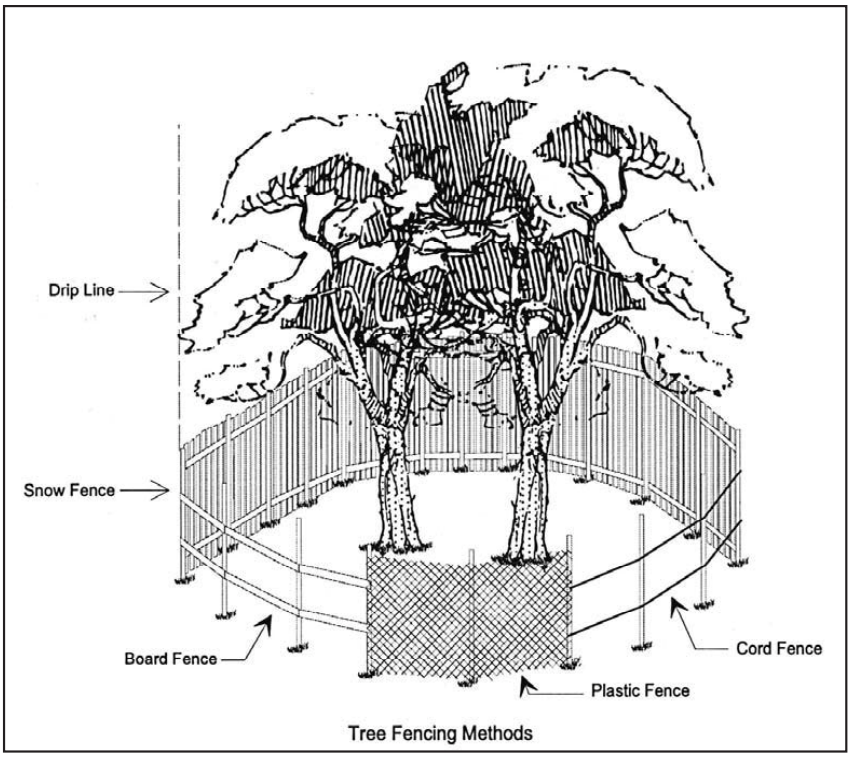

Figure 6.8 Erecting Barriers for Tree Protection Source: *Adapted from MU Guide 6885*

For example, a tree with a diameter (breast height) of 20 inches will have a critical root radius of 30 feet (60 foot diameter).

Construction

- Install temporary fences at tree driplines (at the critical root radius for sensitive tree species). To avoid compaction of the soil around desired trees, keep traffic, equipment and supplies off of the root systems. Figure 6.8 shows the correct method of erecting barriers for tree protection.
- Route the underground utilities according to plan. If possible, combine in one trench and route away from trees and potential planting sites.
- Use a brush cutter, rotary axe, or cut by hand instead of grading off brush to maintain the area within the tree canopy perimeter.

  Note: If grading beneath a tree's canopy is indicated on the plan:

  - Prior to construction activities, prune low hanging branches that may be damaged by equipment. To avoid tearing the bark from the tree while pruning, remove large branches with a stub-cut method. Figure 6.9 illustrates correct methods of pruning.
  - Minimize grading beneath the tree canopy. Avoid placing fill, or removing leaf litter or soil in the ungraded areas. Cut large roots instead of tearing them with equipment.

Stub-cut Method

First, make an undercut about one foot from the trunk. Then, cut through the branch near the first cut. Leave the tree's branch collar intact during the final cut to promote healing. Source: *Adapted from MU Guide 6866*

Construction Verification

Check the construction site to verify protective measures are being observed.

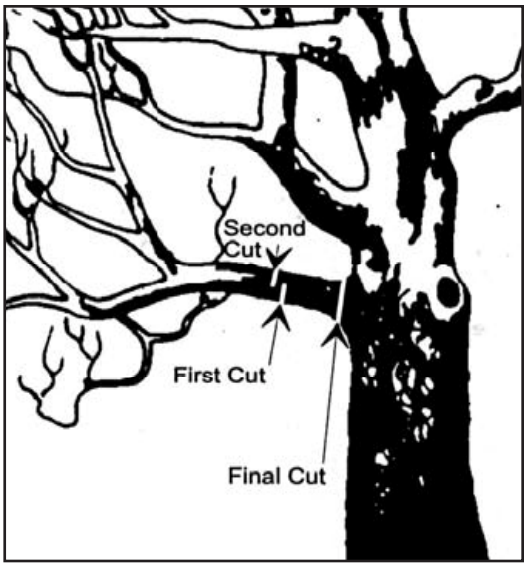

Figure 6.9 Proper Method of Pruning
Source: *Adapted from MU Guide 6866*

Troubleshooting

Consult with registered design professional such as an arborist or silviculturist if any of the following occur:

- A protected tree is accidentally injured by construction activities.
- If grade around a protected tree must be raised.

Maintenance, Inspection and Removal

- Remove fence around protected trees only after all construction is complete and all disturbed soil is stabilized.
- In spite of these precautionary steps some damage may occur to desired trees. If minor damage occurs, repair it immediately. Repair damage to limbs or roots by cutting off the damaged areas. Repair damage to bark by trimming the perimeter of the damaged area. If there is any question about the correct course of action, enlist the service of a professional arborist or silviculturist.
- Inspect trees for signs of stress, such as insect, disease and drought damage. Stressed trees should be watered during dry periods. Soak area under the canopy to a depth of 12- to 18-inches. Avoid fertilizing severely stressed trees until they become reestablished a year or two later. Treat insect and disease problems with a pesticide, if necessary, but be sure to follow instructions on the label. Or, employ a certified pesticide applicator to treat the problem.
- Remove temporary devices and stabilize the site prior to filing *Form H - Request for Termination of a General Permit*, Form--MO 780-1409 (see Chapter One - Missouri Permit Requirements).

Common Problems and Solutions

Problem	Solution
Trees show signs of damage such as wilting, early leaf drop in the fall or slow growth often caused by compaction.	Aerate the soil by pulling 12- to 18- inch deep cores in the soil within the dripline to assist movement of moisture and oxygen into the soil, then backfill with compost.
Trees killed during construction.	Remove after site completion and replace with new trees.

Parking and Material Laydown Areas

Figure 6.10 Laydown and storage areas should be neat and fully stabilized. Source: *ABC's of BMP's*

Practice Description

Many construction sites have a designated area for a construction trailer, parking and storage of construction material usually referred to as a laydown area. The area itself is not considered a best management practice but management of the area is.

Recommended Minimum Requirements

This area should be within the permitted area to be disturbed and should be located no closer than 100 feet from streams, wetlands, natural drainageways or other environmentally sensitive areas. Although the tendency is to park vehicles in shaded areas, this area should not be placed within the canopy of plants expected to remain on-site. The root zone of plants is generally as broad as the canopy. The area should be stabilized with vegetation or a small rock and gravel base depending on the amount of traffic in the area and should not contribute pollutants to the stormwater discharge. The area should be clearly marked on the SWPPP site map.

Construction

The parking and laydown areas as well as the traffic paths into and out of these areas should be stabilized. They are most often placed near the exit of the construction site and therefore can contribute to off-site sediment tracking if not managed properly.

Troubleshooting

Keep the area free and clear of trash and debris. Provide a location for trash disposal (e.g., dumpster) in an appropriate location. See the Solid Waste section under Pollution Prevention.

Maintenance, Inspection and Removal

- Inspect the area on a weekly basis and after rain events.
- Ensure that materials are properly stored and contained with Material Safety Data Sheets, or MSDS, information readily available.
- Removal of this temporary device must be performed and the site stabilized prior to filing *Form H - Request for Termination of a General Permit*, Form--MO 780-1409 (see Chapter One-Missouri Permit Requirements).

Common Problems and Solutions

Problem	Solution
Sediment is being transported onto a public street when exiting the parking or laydown area; the area is eroding or traffic carries mud to the street.	Add rock over the area to stabilize it.
Vehicles sink into the soil caused by a soft subgrade.	Lay a geotextile membrane over the area and add a layer of small rock or gravel.

Temporary Stream Crossing

Practice Description

A temporary stream crossing is a short term crossing constructed over a stream for use by construction traffic. Temporary stream crossings can be designed as low water crossings, as an embankment with a culvert, or as a bridge with or without embankment approaches. Properly constructed, they prevent on going turbidity and streambed disturbance caused by construction traffic. Improperly designed and constructed stream crossings can cause upstream flooding, channel erosion during increased flows and failure of temporary crossings.

Temporary stream crossings may be subject to applicable federal, state and local regulations for in-stream modifications. Contact the U.S. Corps of Engineers and local authorities for possible permit regulations.

Recommended Minimum Requirements

Prior to start of construction, temporary stream crossings should be designed by a registered design professional. Plans and specifications should be referred to by the site superintendent and field personnel throughout the construction process.

Drainage Area

Any size, however most temporary stream crossings occur on smaller headwater stream located within smaller drainages.

Slopes

Low Water Crossing

- 3:1 or flatter for downstream slope.
- 2:1 or flatter for upstream slope.

Culvert Crossing

- 2:1 or flatter for downstream and upstream slope.

Low Water Crossings

Water Flow

Shallow (less than 3 inches deep) or intermittent.

Traffic Usage

Light

Bank Height

Less than 5 feet.

Approaches

Slope of 5:1 or flatter.

Culverts

Minimum Diameter

- 18 inches or according to design plan.
- Large enough to pass the peak flow from the 2-year 24-hour rainfall event of the design storm.

Minimum Height of Fill Over Culvert

1 foot or 1/2 the pipe diameter, whichever is greater.

Culvert Length

Sufficient to extend the full length of the driving surface and the side slopes.

Construction

Locate the temporary stream crossing where erosion potential is low. Riffle locations within the channel generally are preferable locations to stream pools. Where practical, locate and construct stream crossings to serve as both temporary and permanent crossings to keep stream disturbance to a minimum.

Site Preparation

- Plan stream crossing in advance and attempt to construct them during dry periods to minimize stream disturbance.
- Follow all federal, state and local requirements on temporary road crossing.
- Ensure that all necessary materials are on the site before any work begins.
- Construct a bypass channel before undertaking other work. Refer to plans.
- Scarify the creek bed before placing fill.

Dewatering Site

- Stabilize the bypass channel with riprap or other suitable material when stream velocity exceeds that allowed for existing soil material.
- Divert the stream to the bypass channel.

Low Water Crossing

- Locate low water crossings only where normal flow is shallow (less than 3 inches deep) or intermittent, and where traffic is light. See Figure 6.11.
- Excavate the foundation for the temporary crossing. Place crossing straight across stream.
- Excavate roadways through the abutment approaches (bank) to the crossing according to the design plan.
- Place large rock riprap across the channel. Construct a wearing course of gravel or crushed rock over the riprap. Use geotextile between crushed rock and the riprap.
- Remove gravel and excess rock riprap as soon as it is no longer needed. Restore original contours to the channel, leaving rock riprap level with the streambed.

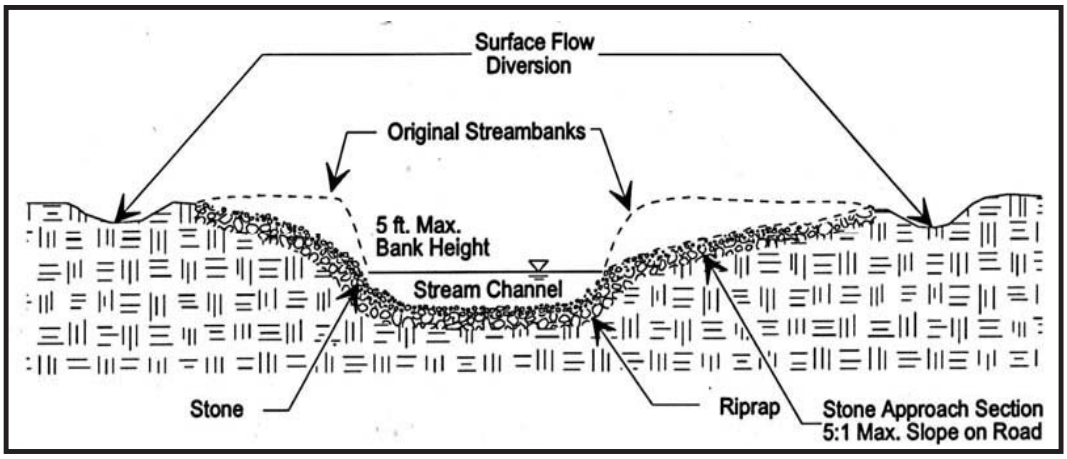

Figure 6.11 Typical low water stream crossing.

Culvert Crossing

- Excavate the foundation for the temporary stream crossing.
- Divert the stream flow. Prepare the pipe bedding. Situate the culvert pipe on a firm, even foundation and keep the culvert parallel to the direction of flow. See Figure 6.12.
- Place a 4-inch layer of moist, clayey, workable soil (not pervious material such as sand, gravel or silt) around the culvert. Compact by hand to at least the density of the embankment soil. (Don't raise the culvert from the foundation when compacting under the culvert haunches.)
- Extend the end of the culvert beyond the toe of the fill slope or install a riprap apron at least 5 feet wide and 10 feet long to a stable grade.
- Remove culvert as soon as it is no longer needed. Restore streambed to original contour.

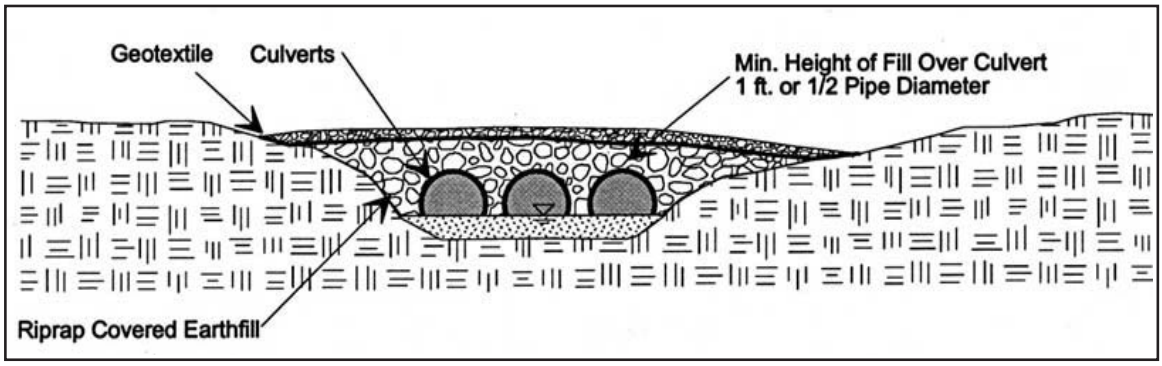

Figure 6.12 Typical temporary culvert stream crossing.

Bridges

- Properly designed bridges cause the least disturbance to the stream bed, banks and surrounding area. They are the preferred method for temporary stream crossings.
- Disadvantages to constructing temporary bridges include:
  - They are the most expensive option to construct
  - They are the greatest safety hazard if not adequately designed, constructed and maintained.
  - They cause a longer construction delay if washed out.
- Bridges must have stable abutments. It is recommended that a cable be tied to one corner of the bridge frame with the other end fastened to a secure object to prevent flood flows from carrying the bridge downstream where it may cause damage to other property.

Embankment for Bridges and Culverts

- Use fill from predetermined borrow areas. It should be clean, stable mineral soil free of roots, woody vegetation, rocks and other debris and must be wet enough to form a ball without crumbling yet not so wet that water can be squeezed out.
- Compact the fill material in 6- to 8-inch continuous layers over the length of the embankment. (One way is by routing construction equipment over the embankment so that each layer is traversed by at least one wheel of the equipment.)
- Protect the culvert with 2 feet of hand-compacted fill before traversing over the pipe with equipment.
- Construct and compact the temporary road crossing embankment to 10 percent above the design height to allow for settling.

Erosion Control

- Unlike permanent stream crossings, temporary stream crossings may be allowed to overtop during peak storm periods. However, the structure and approaches should remain stable. Keep any stockpiled fill located flood plains to a minimum to prevent upstream flooding and reduce erosion potential.
- Minimize the size of all disturbed areas and vegetate as soon as each phase of construction is complete. Riprap or establish vegetation on the slopes of the embankment in the temporary stream crossing.
- Direct all overland flow to the ditches along the approach roads at low velocity.

Safety

Because temporary stream crossings are potentially hazardous, take the following precautions:

- If site conditions warrant, construct guardrails or axle berms along the sides of the temporary stream crossing.
- Avoid steep slopes on the embankment; slopes should be kept as flat as possible (3:1 or flatter).
- Approach road slopes should be 5:1 or flatter.

Construction Verification

Check finished grade and both the size and orientation of culvert within the stream. Check to see if culverts are free of obstructions.

Troubleshooting

Consult with registered design professional if any of the following occur:

- Variations in topography and stream conditions on-site indicate crossing will not function as intended; changes in plan may be needed.
- Design specifications for fill or conduit cannot be met; substitution may be required. Unapproved substitutions could result in the crossing being washed out.

Maintenance, Inspection and Removal

- Inspect the temporary stream crossing on a weekly basis and after each storm event. Pay close attention to the condition of the entrance and exit sections of the culvert pipe, the culvert joints, the abutment supports for bridges, all bridge connections and the amount of erosion on low water crossings.
- Add riprap to the culvert entrance and exit as necessary to protect the crossing.
- Periodically check the embankment for erosion damage, settling or slumping and repair immediately.
- Correct any problems immediately upon observing them. Do not wait until a scheduled weekly inspection to address a failure or potential hazard noted during routine activities.
- Remove debris, trash and other materials that restrict flow from the culvert or bridge.

Common Problems and Solutions

Problem	Solution
Piping failure along culvert caused by improper compaction, leaking pipe joints or use of unsuitable soil.	Repair piping damage and ensure culvert joints are sealed before properly compacting suitable soil around the culvert to prevent reoccurrence of the problem.
Erosion of embankment slopes caused by inadequate vegetation or improper grading and sloping.	Repair erosion damage and reevaluate erosion protection measures.
Slumping or settling of embankment; caused by inadequate compaction or use of unsuitable soil.	Return embankment to original configuration using properly compacted soil as specified in the original plans.
Slumping failure; caused by steep slopes.	Remove slide debris and replace with properly compacted soil.
Erosion and streambank caving below culvert; caused by inadequate outlet velocity protection.	Repair erosion damage and provide adequate outlet velocity protection.
Difficult and costly maintenance; caused by culvert not set in direction of flow in stream.	Consult registered design professional for other options.
Overtopping of roadway, ponding upstream of the culvert and erosion beneath the culvert caused by culvert entrance elevation set too high.	Repair erosion damage, and either reevaluate size and elevation of the culvert or raise the roadway elevation.
Frequent overtopping of roadway and increased erosion potential caused by the culvert or bridge opening being too small.	Repair erosion damage, and either resize the culvert or raise the roadway elevation.
Downstream scour and undermining of structure during flooding caused by roadway elevation too high.	Repair damage and resize or lower culvert.

Slope Breaks and Surface Roughening

Figure 6.13 Lot benching can shorten slope length and prevent erosion while improving the homeowner's yard. Source: *C. Rahm, NRCS, St. Charles County*

Practice Description

Slope breaks and surface roughening are practices that reshape the ground surface during construction to slow the surface overland stormwater flow and reduce slope length to reduce surface runoff velocities, therefore minimizing soil erosion and sedimentation during construction. Slope breaks and surface roughening are inexpensive ways to provide erosion control during construction prior to establishment of permanent vegetative cover.

Slope breaks, such as diversions or benches, can be used to reduce the length of continuous slopes and reduce erosion (See Diversions).

Recommended Minimum Requirements

Prior to start of construction, the site grading plan should be designed by a qualified professional. The grading plan should show disturbed areas, cuts, fills and finished elevations for all graded areas. The site superintendant and field personnel should refer to plans and specifications throughout the construction process. During construction and reshaping of the topography a slope can be roughened once it has been graded out and prior to reaching final grade and vegetation establishment.

Schedule construction activities so the least amount of area is disturbed at one time.

Slope Breaks

Refer to plan. Table 6.1 provides suggested guidelines for spacing of slope breaks.

Soil Surface Roughening

There are many types of surface roughening techniques such as track walking with a dozer up and down a slope or using a sheep's foot to create dimples in the soil surface. This increases infiltration and slows overland flow.

Table 6.1 Guidelines for Spacing Slope Breaks

Slope	Spacing (ft.)
33-50%	20
25-33%	40
15-25%	60
10-15%	80
6-10%	120
3-6%	200
< 3%	300

Source: Adapted from North Carolina Field Manual, 1991

Surface Runoff

Avoid disturbing natural drainage ways, if possible. At each slope break, intercept runoff and channel it to storm drains or stabilized watercourses. If runoff contains sediment, protect drain inlets with a filter or divert water to a sediment trap or basin according to the site grading plan (See Inlet Protection, Temporary Sediment Trap and Sediment Basin).

Erosion Control

Graded areas should be stabilized with mulch, vegetation, crushed stone, riprap or other measures as soon as work is completed, or if work is interrupted for 14 or more working days. Soil surface roughening is both an erosion and sediment control technique and should not be combined with devices such as erosion control blankets. Blankets should be applied to smooth, fine-graded soil surfaces and will fail if used to cover roughened soil surfaces.

Slopes to be Vegetated

2:1 or flatter; 3:1 or flatter where maintained by tractor or other equipment. Slopes should be roughened during grading operations to retain water, increase infiltration and promote vegetative growth. Slopes should be protected from surface runoff while vegetation is being established (See Diversions, Perimeter Protection).

Borrow and Disposal Areas

As shown on the grading plan; these should be no closer than 100 feet to a streambank or sensitive area (e.g., wetland, spring, cave, sinkhole) in the absence of a specification and should not be placed in an area of stormwater conveyance. Stockpiles should be stabilized if not being used for 14 or more days according to the state and local regulatory requirements. If borrow or disposal locations are off-site, they should also be permitted and have a copy of the permit authorization on-site at all times. This is necessary if the off-site borrow or disposal area is used for this construction project only and disturbs one acre or greater requiring permit coverage.

Outlets for Breaks and Diversions

Stabilized outlets should be provided for runoff from the disturbed area in order to retain sediment on-site.

Construction

Site Preparation

- Erosion and sedimentation control measures should be installed as specified and in the sequence shown on the design plan.
- Prior to excavation activities of any type, call1-800-DIG-RITE (344-7483) to obtain utility locations.
- Remove and stockpile topsoil (see Topsoiling) if subsoils will not support plant growth.
- Clear and grub areas to be filled and remove trees, vegetation, roots and other debris.
- Check fill to make sure it is does not contain brush, rubbish, oversized rocks or other objectionable material.
- Place fill in layers and compact as specified by the grading plan. Do not use frozen, excessively soft or high organic content material.
- Do not place fill on frozen subgrade, as it may cause an unstable condition due to potential differential settlement when the soil thaws.

Grading

- Construct slope breaks as shown on the grading plan, or in accordance with the recommendations of Table 6.1. A typical slope break is illustrated in Figure 6.14.
- Keep diversions and other water conveyance measures free of sediment during all phases of development.
- Avoid grading and building in areas of seepage. If this cannot be avoided, then install subsurface drains (See Subsurface Drains) in areas where seepage interferes with the grading operations, or where required to improve slope stability or soil bearing capacity.
- Permanently stabilize graded areas immediately after final grading is complete. Use temporary stabilization measures on graded areas when work is to be interrupted or delayed for 14 working days or longer.

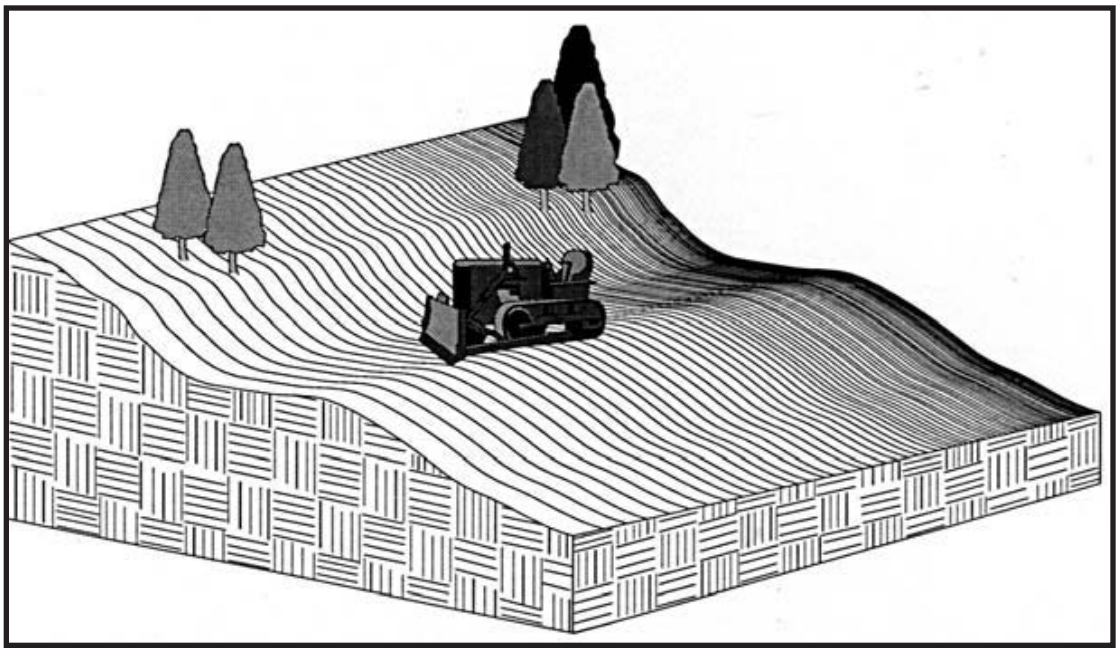

Figure 6.14 Typical Slope Break

Construction Verification

Check all finished grades for conformance with grading plan and correct as necessary.

Figure 6.15 Track walking with a dozer up and down the slope provides horizontal grooves to reduce stormwater flow volumes and velocity therefore reduces potential for erosion of the slope. Source: *ABC's of BMP's, LLC*

Maintenance, Inspection and Removal

- Periodically inspect all graded areas and the related erosion and sedimentation control practices, as required by the construction general permit, especially after heavy rainfalls. Clean sediment out of diversions and other structures as needed. If washouts or breaks occur, repair them immediately.
- Remove this is a temporary device and stabilize the site *Form H - Request for Termination of a General Permit*, Form--MO 780-1409 (see Chapter One - Missouri Permit Requirements).

Common Problems and Solutions

Problem	Solution
Variations in topography on-site indicate grading plan will be ineffective or unfeasible.	Consult with design professional
Seepage is encountered during construction.	It may be necessary to install drains. Dewatering shall be performed in accordance with regulatory requirements.
Design specifications for seed variety, seeding dates, erosion control materials or timeframes cannot be met.	Substitutions may be required. Unapproved substitutions could result in erosion and lead to failure of erosion control measures.
Prominent rill and gully erosion caused by slope breaks being too far apart.	Construct intermediate slope breaks.
Difficulties achieving proper compaction of fill caused by subgrade being soft, contains oversized rocks or has high organic content.	Undercut and replace unsuitable subgrade soil.
Slope is unstable or has reduced bearing capacity caused by a high water table	Install subsurface drains to lower water table.

Topsoiling: Removal, Stockpiling and Replacement

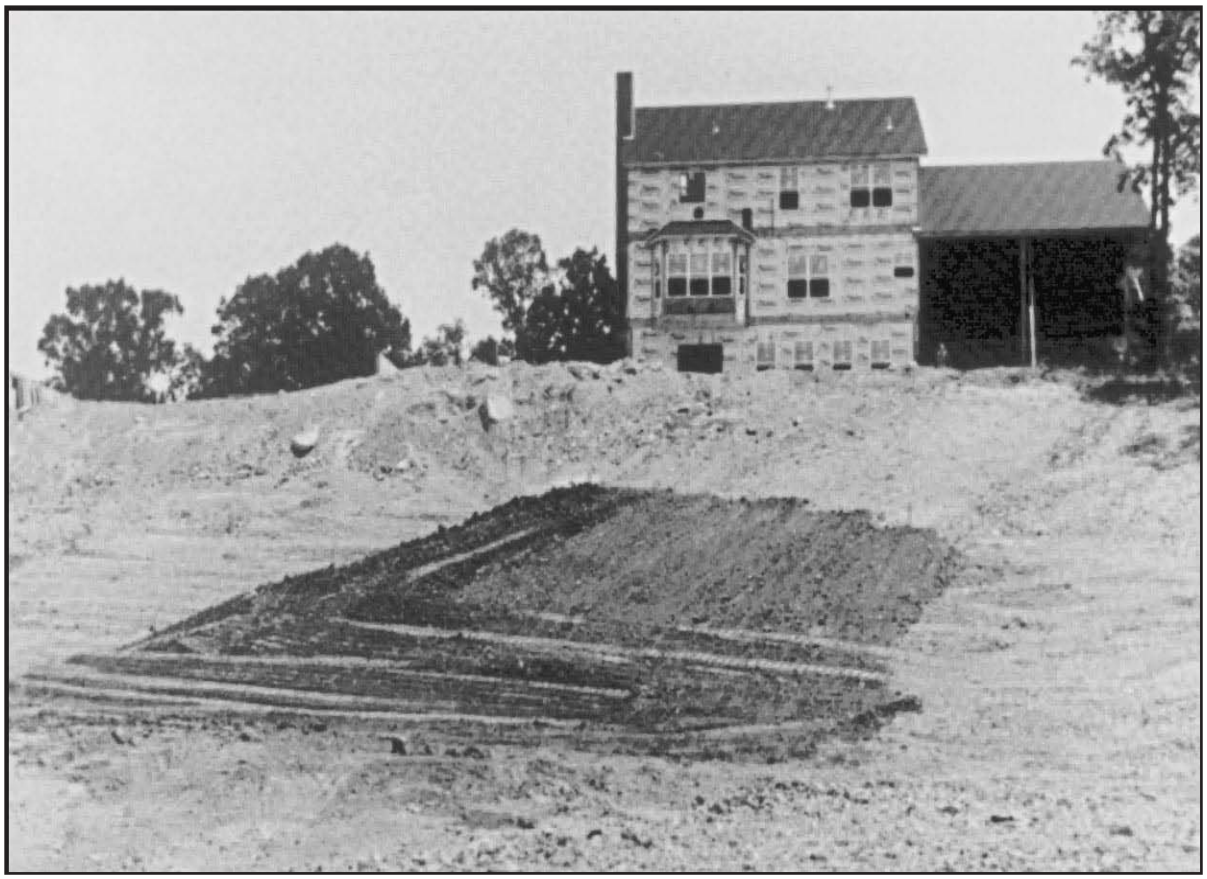

Figure 6.16 It's important to mix or incorporate topsoil with the underlying subsoil to prevent sloughing on sloping soils.
Source: *C. Rahm, NRCS. St. Louis Co.*

Practice Description

Topsoiling is a method of preserving the topsoil prior to construction, stockpiling it and using it after construction to help establish vegetation on a construction site. Stockpiling is also used for storage of other soils and construction material such as fill material. These practices apply to areas on a site to be disturbed by excavation, compaction or filling, and where vegetation is to be reestablished.

Recommended Minimum Requirements

Prior to the start of construction, topsoiling should be designed by a qualified professional. The existing soil should be tested to ensure the material to be saved is topsoil and helps with vegetation establishment and long-term, permanent growth. The location of other material to be stockpiled on the site should be shown on the site map and stabilized according to the regulations. Refer to the plans and specifications throughout the construction process.

Topsoil

- Surface soil or top layer of undisturbed soil, usually richest in organic matter and nutrients.
- Should be free of debris, trash, stumps, large rocks, roots and noxious weeds. It should contain no substance potentially toxic to plant growth.

Minimum Soil Depth

- 24 inches of total soil depth over bedrock (combined topsoil and subsoil); from 8- to 12-inches of total soil depth over loose sand or rock.
- The top 4- to 6-inches of soil must be good topsoil, rich with organic matter, microorganisms and not more than 50 percent clay content to ensure good vegetation establishment and growth on a permanent basis.

pH Range

- From 6.0 to 7.5.
- If the pH is less than 5.2, lime should be incorporated in accordance with soil test results.

Construction

Site Preparation

- Establish all perimeter erosion and sediment control practices, (e.g., sediment barriers, diversions, grade stabilization structures, berms, dikes, sediment basins) before stripping.

Stripping

- Strip topsoil from areas that will be disturbed by excavation, filling or compaction by equipment.
- Determine depth of stripping by taking soil cores at several locations within each area to be stripped.
- Make sure the soil being saved is topsoil. It should have a minimum of five percent organic material and a clay content of less than 50 percent.

Stockpiling

- Do not place topsoil or other stockpiles near areas of water (e.g., conveyances, ditches, swales).
- Do not place stockpiles on impervious surfaces or within 50 feet of storm drain inlets.
- Avoid placing topsoil or stockpiling other material on steep slopes. Side slopes of stockpile should not exceed 2:1.
- Use sediment fences or other barriers where necessary to retain sediment.
- Protect topsoil and other stockpiles with temporary seeding or other soil stabilization techniques as soon as possible, but not more than 14 working days after formation of the stockpile. If stockpiles will not be used within 12 months, they should be stabilized by permanent vegetation to control erosion and weed growth.

Grading

Established grades should be maintained according to the approved plan and should not be altered by adding topsoil.

Liming of Subsoil

Where the pH of the existing subsoil is below 5.2, incorporate agricultural limestone in amounts indicated by soil tests or specified for the seeding mixture to be used (See Temporary or Permanent Seeding). Incorporate lime into the subsoil to a depth of at least two inches by disking. Retest the soil to determine the pH and if pH is not 5.2 or higher, repeat the process.

Roughening

Immediately prior to spreading topsoil, loosen the subgrade by disking or scarifying to a depth of at least two inches to ensure bonding of the topsoil and subsoil.

Spreading Topsoil

- Spreading frozen or muddy topsoil can prevent proper grading or seeding. Uniformly spread topsoil to a minimum compacted depth of four inches. For long-term growth of vegetation without irrigation, minimum soil depth (subsoil and topsoil) should be 8- to 12-inches over loose sand or rock fragments, and 24 inches over bedrock.
- Prior to the establishment of final vegetation, the topsoil should be final graded so it is smooth with no clods greater than one inch in diameter.

Construction Verification

Verify that topsoil was spread evenly and incorporated with underlying subsoil.

Maintenance and Inspection

- Maintain erosion control devices over topsoil until vegetation is fully established with a density of 70 percent over the entire area.
- Inspect topsoiled areas frequently until vegetation is established.
- Repair eroded or damaged areas and revegetate.

Common Problems and Solutions

Problem	Solution
Poor or no vegetation establishment caused by topsoil pH too low.	Add agricultural limestone to adjust pH.
Poor or no vegetation establishment caused by topsoil containing sterilants or toxic chemicals.	Remove contaminated topsoil and replace.
Poor or no vegetation establishment caused by topsoil being too high in clay content or too low in organic material and microorganisms.	Add organic material.
Poor vegetation establishment caused by topsoil being compacted too much during application.	Loosen by disking or scarifying and reseed.
Poor drainage and possible sloughing on steep slopes caused by topsoil not properly bonded to subsoil.	Remove topsoil, roughen subgrade and respread topsoil.
Inadequate vegetation establishment caused by topsoil removed during construction and not replaced.	Add topsoil with a minimum of 5 percent organic material, a clay content under 50 percent, fertilize according to soil test results, reseed or sod site, and apply water to establish vegetation.