Vermont Erosion Prevention and Sediment Control Field Guide

August 2006

Vermont Erosion Prevention and Sediment Control Field Guide

The purpose of the VT Erosion Prevention and Sediment Control (EPSC) Field Guide is to describe the basic EPSC practices that can be implemented on a construction site and to assist the On-Site Coordinator at a construction site in making discretionary changes to the EPSC Plan.

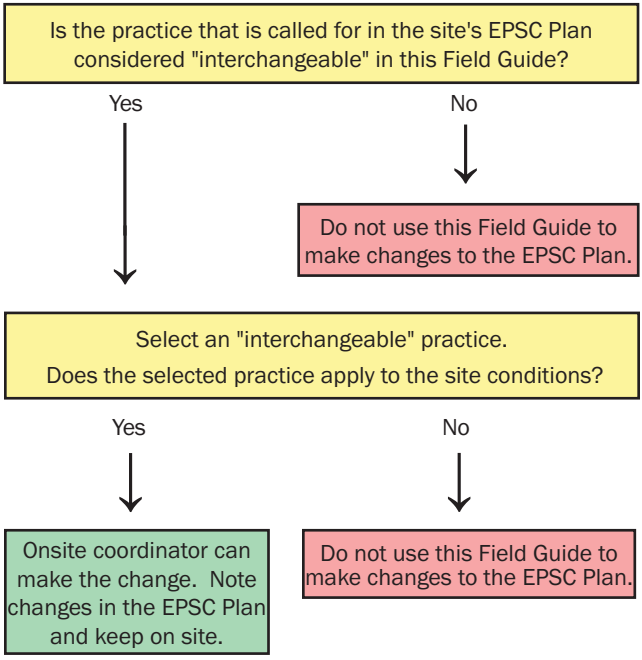
Sections 1 and 2 include information on pre-construction planning and phasing of construction operations.

Sections 3 - 8 include detailed information on practices that are considered interchangeable for preventing erosion and controlling sediment on the construction site. The On-Site Coordinator may substitute a practice called for in the site's EPSC Plan with a practice listed as "interchangeable" in this Field Guide.

If there is not an interchangeable practice listed in this guide for a practice that is called for in the site's EPSC Plan and a change needs to be made to the plan, the change must be designed and certified by a Plan Designer, Professional Engineer, or Certified Professional in Erosion and Sediment Control (CPESC).

All plan changes must be kept on-site with the EPSC Plan.

Use the following chart to determine if a practice can be substituted in the field.



This guide does not replace the Vermont Standards and Specifications for Erosion Prevention and Sediment Control nor does it replace the prepared Erosion Prevention and Sediment Control Plan.

Clean runoff starts with you.

This *Field Guide* will take you through the erosion prevention and sediment control process. The guide starts out with sections on pre-project planning and operational activities. The rest of the guide discusses erosion prevention and sediment control by starting at the top of the hill, above the project site, and proceeding down the slope through the bare soil area, ditches and channels, and down to the waterways below. The drawing below summarizes this approach.

Preserve existing vegetation

Divert upland runoff around exposed soil

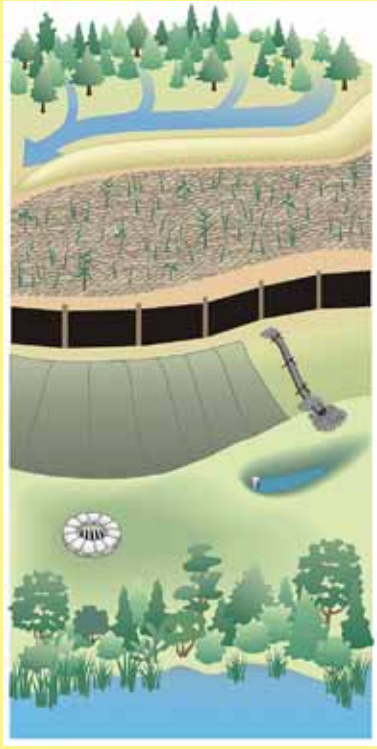
Seed/mulch/ cover bare soil immediately

Use sediment barriers to trap soil in runoff

Protect slopes and channels from gullying

Install sediment traps and settling basins

Preserve vegetation near all waterways



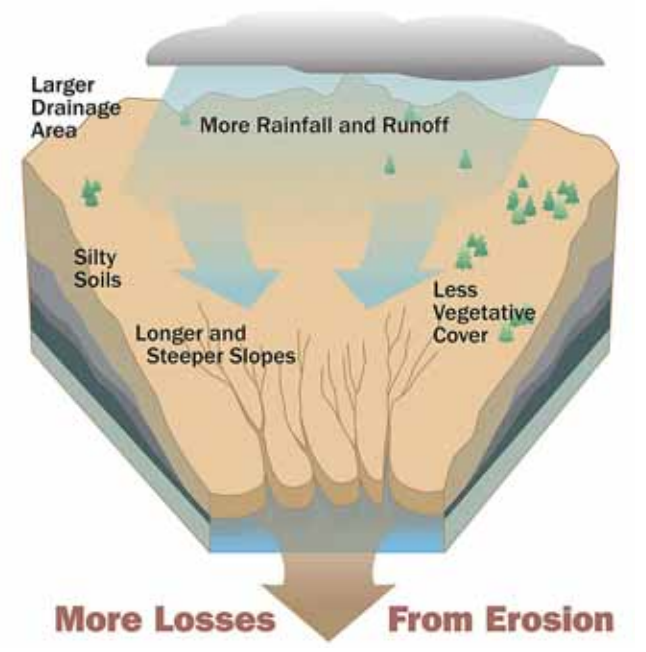
Why do we need to control erosion and sediment losses from construction sites?

Sediment washing into streams is one of the largest water quality problems in Vermont. Sediment can kill or weaken fish and other organisms and impact aquatic wildlife habitat`. It is not difficult to reduce erosion and prevent sediment from leaving construction sites. Follow the basic approach shown above. Sites with steep slopes near waterways need more controls than flat sites farther away.

Observe basic principles such as: 1) Preserve existing vegetation as much as possible; 2) Mulch or seed bare soil immediately for the best and cheapest erosion protection; 3) Use silt fences, brush barriers, or other approaches to intercept and filter sediment from runoff; 4) Install silt check dams made of rock, brush, or other products to prevent ditch erosion and remove sediment; 5) Protect inlets and outlets; and 6) Settle out soil particles in sediment traps and basins.

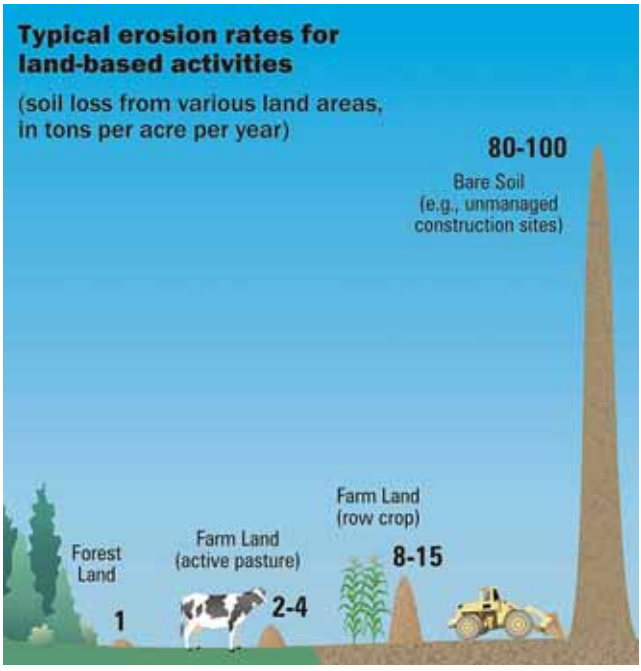
Table of Contents

What contributes to erosion?



Factors influencing erosion. Heavy rainfall, steep slopes, removal of most existing vegetation, and erodible soils result in higher soil losses from erosion.

Lower rainfall amounts, flatter slopes, preserving existing vegetation, and less erodible soils result in lower soil losses from erosion.



What contributes to erosion?

- Removing vegetation
- Removing topsoil and organic matter
- Changes to drainage
- Exposing subsoil to precipitation
- Failure to cover bare soil areas
- Allowing gullies to form and grow larger
- Removing vegetation along stream banks

What other factors affect erosion?

Rainfall frequency and intensity

Slope (steep = more erosion; flat = less erosion)

Soil structure and type of soil (silty = more erosion)

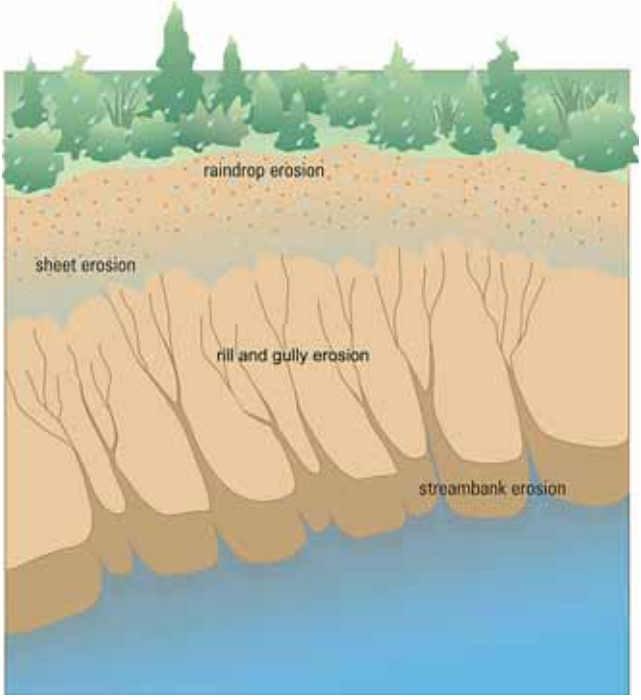
Vegetation (more vegetation = less erosion)

Erosion and sediment controls for runoff:

- Soak it in—maximize seeding and mulching
- Sift it out—use silt fences
- Slow it down—don't let gullies form
- Spread it around—break up concentrated flows
- Settle it out—use sediment traps and basins

Types of Erosion

Types of erosion. Raindrop erosion (top) breaks down soil structure. Slope runoff creates sheet erosion, which can lead to the formation of small rill channels and larger gullies (below). Erosion of unprotected stream banks can be caused by removing vegetation and higher flows caused by runoff from pavement, sidewalks, and roofs in newly developed areas.



SECTION 1

Pre-Construction Planning

Planning your construction project can help you avoid costly mistakes in controlling erosion and sediment loss to nearby waterways. Follow the steps below before you begin clearing, grading, and excavation work. If your project is one acre or larger, you will need a construction stormwater permit from the Vermont Department of Environmental Conservation (VT DEC) Stormwater Section (802-828-1535, or see dec.vermont.gov/watershed/stormwater)

Assess soils and slopes on the construction site

The erosion potential on your construction site depends in part on the soil type and slope steepness at your site. See the table below.

Erosion Potential for slope and soil conditions

Soil Type and Parameters	Slope %		
	0 - 5 %	5 - 15%	> 15%
Gravelly	Low	Low	Medium
Sandy	Medium	High	High
Silty	Medium	High	Very High
Clay	Low	Medium	High
Dispersive Clay Soils	High	Very High	Extreme

Note: there are other factors that contribute to erosion, such as slope length and rainfall intensity and duration. Also, even though there may be low potential for erosion, there can be a high risk to water quality when the soil disturbance is close to water resources.

Identify nearby streams and drainage control points

Walk over the site and find where ditches or other concentrated flows leave the site. These are the final sediment control points. Sediment traps or basins should be installed just above these control points. Your site may drain to an underground storm sewer system. In this case, the storm drain inlets that drain runoff from your site are the control points and must be protected (see Section 7). These are also the compliance points for any permits issued for the site.

Install clean water diversions, sediment traps/basins, grassed ditches, silt check dams, and sediment barriers such as silt fences *before* clearing and excavation work begins!

Preserve existing vegetation wherever possible

Only dig or grade where necessary. Existing trees, bushes, and grass help keep erosion to a minimum. Protect large trees by marking off a no-dig root protection zone that is twice as large as the outer perimeter of the branches. Plan your project to limit the amount of bare soil area exposed to the weather, and limit the amount of exposure time. Do not clear vegetation or excavate areas near streams, rivers, lakes, or wetlands without getting the required state and federal permits!

Preserve vegetated buffers

Preserve existing vegetation near waterways wherever possible. This vegetation is the last barrier to capture sediment runoff before it enters the lake, river, stream, or wetland. Where vegetation has been removed or where it is absent, plant native species of trees, shrubs, and grasses.

Design projects to fit the natural topography

Minimize clearing and grading to preserve mature vegetation and save money. Identify natural landscape features you want to keep, like large trees, wildflower areas, grasslands, streams, and wetlands. Plan ways to fit your project around these features, so they remain in place after construction is completed. Be sure to mark off these areas with colored ribbon or stakes and warn equipment operators of their location!

Minimize impervious surfaces

Keep the amount of roof area, parking lots, driveways, and roads to a minimum. Design these hard surfaces so that rain water they collect is directed onto landscaped or yard areas, not into ditches or streams. For example, design roads slightly higher than adjacent lawn areas, and use swales instead of curbs along roadways.

Promote infiltration in project design

Moving storm water runoff from hard surfaces to landscaped or yard areas helps runoff soak into the soil. This promotes groundwater recharge, filters sediment and other pollutants from runoff, and helps to prevent flooding.

Develop an erosion and sediment control plan

Develop a written site plan for your project that shows the drainage patterns and slopes, areas of disturbance (cuts/fills, grading), location of erosion and sediment controls, location of surface waters and wetlands, and the location of storm water drainage control points. Your site plan must be updated as conditions change at the site.

Design specifications for erosion prevention and sediment control are included in the **Vermont Standards and Specifications for Erosion Prevention and Sediment Control.**

This manual is available for download at: dec.vermont.gov/watershed/stormwater.

Prioritization of erosion and sediment controls for construction sites

Practice	Cost	Effectiveness
Limiting disturbed areas through **phasing**	$	💧💧💧
Protecting disturbed areas through **mulching and revegetation**	$ $	💧💧💧
Installing diversion around disturbed areas.	$ $ $	💧💧💧
Sediment removal through **detention** of all site drainage	$ $ $ $	💧💧
Other **structural controls** to treat sediment-laden flow	$ $ $ $ $	💧

The cheapest erosion and sediment controls are the most effective. For example, limiting the amount of bare soil by phasing your project and preserving existing vegetation are less expensive and work better than installing large storm water control basins or ponds.

Limiting the amount of bare soil exposed to the weather by working in phases reduces erosion and sediment control expenses. In this residential subdivision, only a few home sites are under construction at one time.

Preserving existing vegetation at the site makes the final development more attractive and saves money by reducing clearing, excavation, and erosion control expenses.

Erosion and sediment controls are required for all construction sites one acre or larger under new federal, state, and local regulations. Erosion Prevention and Sediment Control plans must be written up before the project begins. Permit coverage is also required before clearing, grading, or other cut/fill activities start.

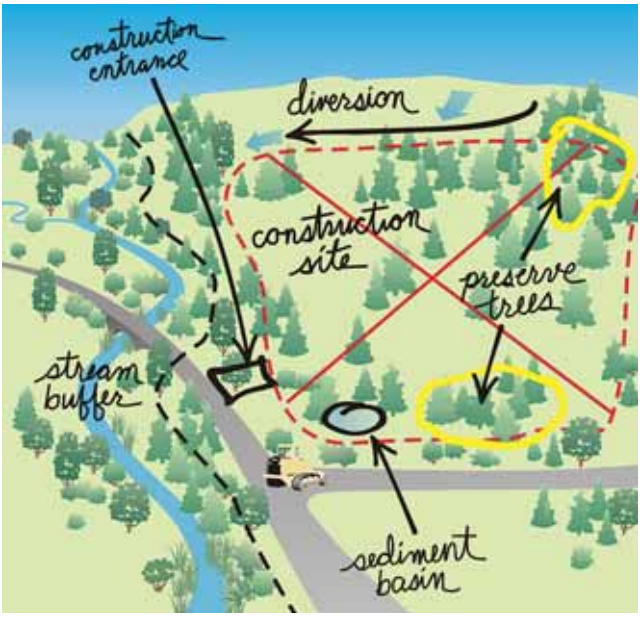
A sign displaying a copy of the project's Notice of Intent (NOI) must be conspicuously placed near the main entrance of the construction site. See your construction permit for posting requirements. A copy of the EPSC plan and all amendments must be kept on site from the date of commencement of construction activities to the date of final stabilization.

SECTION 2

Construction Phase Operations

Divide your construction site into natural drainage areas, so you can deal with each one individually. You will be controlling erosion on bare soil areas by applying seed, mulch, or sediment barriers, and minimizing the time bare soil is exposed to the weather. Control points for sediment in runoff will be at the curb inlets or in the ditches, channels, or sediment traps/basins installed where concentrated flow leaves the site.

Install clean water diversions, sediment traps/basins and stabilize drainage channels with grass, liners, and silt check dams *before* excavation, fill, or grading work begins (see Section 8). Install silt fences and other sediment barriers downhill from bare soil areas before clearing or excavation work begins (see Section 5).



Identify drainage areas and drainage ditches and channels. Install diversions, grassed channels, sediment traps/basins, downslope sediment barriers, and rock construction entrance before beginning work.

Phase your construction work to minimize exposed soil areas

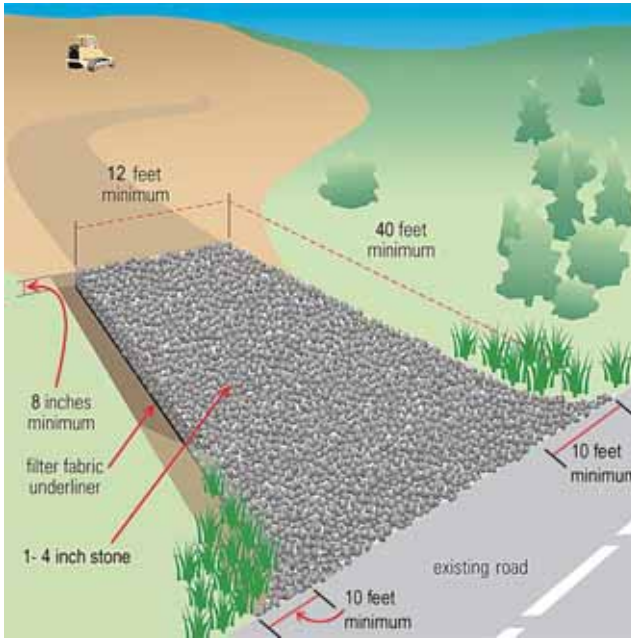
Excavate or place fill material at the site in stages, to avoid exposing large areas of bare soil to the elements. Projects should be cleared and graded as

construction progresses. Check your EPSC Plan for your site's permitted disturbance area. Establish final grade quickly, then seed, mulch, or cover bare soil. If work will proceed over several weeks or months, apply temporary seeding or mulch until final grade work is completed. **Seed and mulch as soon as possible and as per your permit requirements.**

Excavation and grading work should be done during dry weather if possible. Prepare for rainy weather by making sure sediment controls are in place and that all exposed areas are mulched.

Install construction entrances and control dust

Mud tracked onto roads is the number one complaint from citizens regarding construction site operations. Use a matrix of 1 to 4 inch stone for entrance/exit pads leading to roads. Pads should be at least 12 feet wide, 40 feet long, and 8 inches deep. Entrance pads shall not be narrower than the construction entrance. On residential properties, pads may be shorter than 40 feet, as long as they are the length of the driveway. Install filter fabric under the rock to keep it from sinking into the soil below. Rake rock with a grubbing attachment or add new rock if the pad fills with sediment.



Construction entrance detail. Entrance/exit pad must keep mud from tracking onto both paved and dirt roads.

Good stabilized construction exit. Adequate width to accommodate construction traffic and prevent mud tracking onto neighboring streets. Ensure that the pad is 8 inches thick and 40 feet long.

Poor construction entrance. Rock pad is poorly constructed; rock is too small. Use filter fabric under 1 - 4 inch rock. No mud should be tracked onto roads.

Rock sizing and placement look OK for residential site, and very little mud appears on the road. The pad should be at least 8 inches thick and 12 feet wide. Ensure that pad is used as the entrance and exit points - note track marks near curb. Entire area needs seed and mulch.

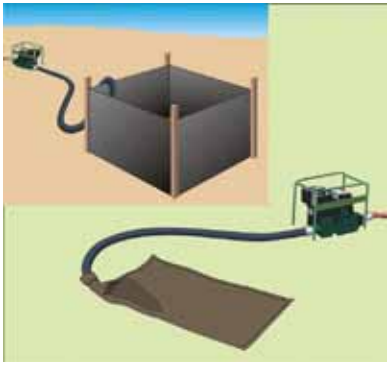
Rock pad was installed properly with right sized rock, but lack of filter fabric underliner is causing rock to spread and sink into the soil. Note tracking of mud onto the road. Mud tracked on roadways violates the permit requirements and is a potential legal liability.

Control dust during hot, dry weather by seeding or mulching bare areas promptly or by wetting haul roads as needed.

Dewatering operations and discharges

Water pumped from collection basins or other areas must not be pumped into storm sewers, streams, lakes, or wetlands unless sediment is removed prior to discharge. **Discharges to streams, lakes, wetlands, or storm sewers needs to be part of the authorized EPSC Plan.**

Use sock filters or sediment filter bags on discharge pipes, discharge water into silt fence enclosures installed in vegetated areas away from waterways, or discharge water into a de-silting basin. Remove accumulated sediment after water has dispersed and stabilize or seed the discharge area. Dispose of sediment in areas where it won't wash into waterways, then grade the area and seed.



Pump water from dewatering operations away from waterways into a silt fence enclosure or use a bag filter or other device to remove sediment. Allow discharge to soak into the ground if possible. Do not pump discharge from dewatering operations into curb inlets, storm sewers, creeks, lakes, or rivers.

Inspection and maintenance of EPSC practices

For sites one acre or larger, the Vermont Construction General Permit requires that you regularly inspect and repair/replace all sedimentation and erosion control measures identified in the EPSC Plan. Discharge locations must also be inspected to ascertain whether erosion control measures are effective in preventing significant impacts to waters of the State.

Your inspection reports must be in writing, and kept with your EPSC Plan at the site. Refer to your construction permit for inspection requirements.

SECTION 3

Diverting Runoff Around Exposed Soils

Keep clean runoff from flowing through your construction site, or route it through stable ditches so it won't pick up sediment. Below are some simple, interchangeable approaches for dealing with upland sources of runoff.

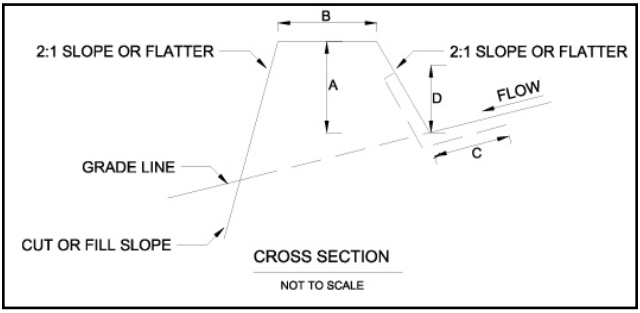
	Condition where practice applies			
Interchangeable practice	Around disturbed area	Across disturbed area	Through the site	Roads and Trails
Earth Dike	x			
Diversion Swale	x	x	x	
Perimeter Dike & Swale	x			
Water Bar				x

Earth Dikes

An earth dike or berm is a long, mounded "collar" of compacted soil located uphill from the excavated area. The dike is designed to intercept overland runoff and direct it around the construction site. This prevents "clean" water from becoming muddied with soil from the construction site. Earth dikes can be temporary or permanent landscape features of the site.

Berms and ditches diverting clean upland runoff around construction sites reduce erosion and sedimentation problems. Stabilize berms and ditches after construction.

Earth Dike Detail



Design Criteria

	Dike I.	Dike II.
Drainage Area	< 5 Acres	5 - 10 Acres
Dike Height (A)	1.5 feet	3 feet
Dike Width (B)	2 feet	3 feet
Flow Width (C)	4 feet	6 feet
Flow Depth in Channel (D)	8 inches	15 inches
Side Slopes	2:1 or flatter	2:1 or flatter
Grade	0.5% Min 20% Max	0.5% Min 20% Max

Channel Stabilization

	Flow Channel	
Channel Grade	**Dike I.**	**Dike II.**
0.5 - 3%	Seed & Straw Mulch	Seed & Straw Mulch
3.1 - 5%	Seed & Straw Mulch	Seed & cover with Rolled Erosion Control Products (RECP), sod or line with plastic or 2 inch stone
5.1 - 8%	Seed & cover with RECP, sod or line with plastic or 2 inch stone	Line with 4-8 inch stone or geotextile
8.1 - 20%	Line with 4-8 inch stone or geotextile	Site specific engineering design

Construction Specifications

1. Compact the dike with earth-moving equipment.
2. Stabilize the channel as per the specifications in the table within 48 hours of installation.
3. Top width may be wider and side slopes flatter if desired to facilitate crossing by construction traffic.
4. Ensure the dike has positive drainage to an outlet.
5. Ensure that there is no erosion at the outlet.
6. Runoff shall be conveyed to a sediment trapping device if the dike channel or drainage area above the dike is not adequately stabilized.
7. The earth dike shall remain in place until the disturbed areas are completely stabilized.

Good construction, seeding, and stabilization of earth dike. Note that diversion ditch is lined with grass on flatter part of slope, and with rock on steeper part.

Well built vegetated dike diverting runoff. Diversion berms and ditches should be seeded after construction. Use stone, RECP, or geotextile if slopes are steep.

Diversion Swales

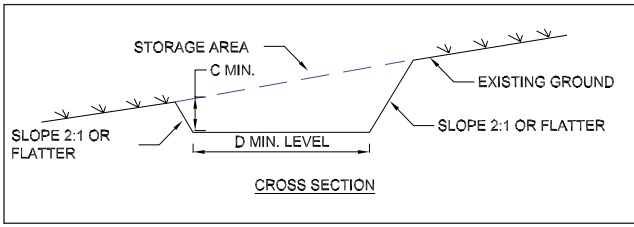
Diversion swales are similar to dikes—they are designed to intercept and divert upland runoff around bare soil areas. Swales are cut above cleared or fill areas and designed with a gentle slope to carry water away from work areas.

Stabilized, lined swales can also be used to move upland water through your site without getting muddy. Construct and line "pass-through" swales before general clearing or grading work begins.

Swales should discharge to areas with thick vegetation or flat surfaces to promote dispersal and infiltration. Gullies must be repaired as soon as they appear.

Good installation of rock-lined berm to divert rain runoff around residential construction site on steep slope near a river. Diversion ditches can be lined with grass if channel slopes are 5% or less, and with stone or geotextile if they are steeper.

Diversion Swale Detail



Design Criteria

	Swale A	Swale B
Drainage Area	< 5 Acres	5 - 10 Acres
Bottom Width of Flow Channel (D)	4 feet	6 feet
Depth of Flow Channel (C)	1 foot	1 foot
Side Slopes	2:1 or flatter	2:1 or flatter
Grade	0.5% Min 20% Max	0.5% Min 20% Max

Channel Stabilization (see Earth Dike)

Construction Specifications

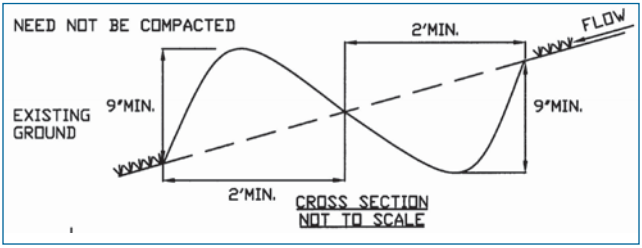
1. Compact the swale with earth-moving equipment.
2. Stabilize the swale as per the specifications for channel stabilization (see Earth Dike).
3. Ensure that the swale has uninterrupted positive drainage to an outlet.
4. Ensure that there is no erosion at the outlet.
5. Diverted runoff from a disturbed area shall be conveyed to a sediment trapping device.
6. All earth removed and not needed for construction shall be stabilized and placed so that it will not interfere with the functioning of the swale.

Diversion swales should be lined with grass at a minimum, and stone or geotextile if slopes exceed 5%.

Perimeter Dike and Swale

A perimeter dike is a temporary ridge of soil excavated from an adjoining swale located along the perimeter of the site or disturbed area.

Perimeter Dike / Swale Detail



Design Criteria

Drainage area - less than 2 acres
Height - 18 inches minimum
(measure from bottom of swale to top of dike)
Bottom width of dike - 2 feet minimum
Width of swale - 2 feet minimum
Grade - not to exceed 8%. Swale shall have positive drainage to a stabilized outlet.

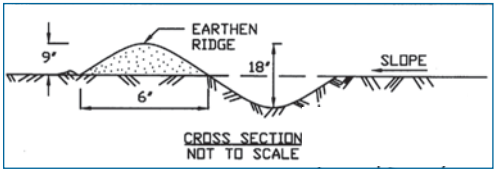
Construction Specifications

1. Stabilize the dike and swale within 48 hours of installation.
2. Install berm on the contour (along the slope).
3. Diverted runoff from a stabilized upland area shall outlet directly onto an undisturbed, stabilized area at a non-erosive velocity.
4. Diverted runoff from a disturbed upland area shall be conveyed to a sediment trapping device.

Water Bar

A water bar is a ridge or a ridge and channel constructed diagonally across a sloping road that is subject to erosion. Water bars limit the erosive velocity of water by diverting surface runoff at pre-designed intervals.

Water Bar Detail



Water Bar Design Criteria

Height - 18 inches min height
(measure from channel bottom to ridge top)
Side Slopes - 2:1 or flatter; 4:1 where vehicles cross
Base width of ridge - 6 feet min
Grade of water bar - not to exceed 2%

Slope	Spacing between bars
< 5%	125 feet
5 - 10%	100 feet
10 - 20%	75 feet
20 - 35%	50 feet
> 35%	25 feet

Construction Specifications

1. Install the water bar as soon as the road or trail is cleared and graded.
2. Disk or strip the sod from the base for the constructed ridge before placing fill.
3. Track the ridge to compact it to the design cross section.
4. The outlet shall be located on an undisturbed area. Field spacing will be adjusted to use the most stable outlet areas. Outlet protection will be provided when natural areas are not adequate.
5. Vehicle crossing shall be stabilized with gravel. Exposed areas shall be immediately seeded and mulched.
6. Periodically inspect water bars for erosion damage and sediment. Check outlet areas and make repairs as needed to restore operation.

SECTION 4

Protecting Soils With Seed, Mulch, or Other Products

Seeding or covering bare soil with mulch, erosion control matting or blankets, or other products as soon as possible is the cheapest and best way to prevent erosion. **Grass seeding alone can reduce erosion by more than 90 percent.** The following practices can be used interchangeably for stabilizing exposed soil.

	Condition where practice applies	
Interchangeable Practices	Slopes shallower than 3:1	Slopes 3:1 or steeper
Seeding and Mulching	x	
Erosion Control Matting and Blankets	x	x
Turf Reinforcement Mats	x	x
Sodding	x	
Bonded Fiber Matrices	x	x

Soil cover requirements

All areas of disturbance must have temporary or permanent stabilization within 14 days of initial disturbance. After this time, any disturbance in the area must be stabilized at the end of each work day.

The following exceptions apply:

- Stabilization is not required if earthwork is to continue in the area within the next 24 hours and there is no precipitation forecast for the next 24 hours.
- Stabilization is not required if the work is occurring in a self-contained excavation (i.e. no outlet) with a depth of 2 feet or greater (e.g. house foundation excavation, utility trenches).

All areas of disturbance must have permanent stabilization within 48 hours of reaching final grade.

NOTE: If the authorization you receive has more protective time limits, then those must be followed.

Seed types and application

Prepare bare soil for planting by disking across slopes, scarifying, or tilling if soil has been sealed or

crusted over by rain. Seedbed must be dry with loose soil to a depth of 12 inches.

Soil amendments should be incorporated into the upper 2 inches of soil when feasible. **The soil should be tested to determine the amounts of amendments needed.** Apply ground agricultural limestone to attain a pH of 6.0 in the upper 2 inches of soil. Check seed bag tags to make sure correct seed is used. Mix seed thoroughly prior to loading seeders. Use the following tables to calculate seed application rates and mixture portions. Apply seed by hand, seeder, drill, or hydro-seed. Drilled seed should be ½ inch deep. Mulch seeded areas as soon as possible.

Apply *more* seed to channels, ditches, lawn, and landscaped areas. Apply less seed to areas that are flat or that will not be mowed very often. Water seeded areas during dry conditions to ensure seed germination and early growth. Re-seed areas that do not show growth within 14 days after rain or watering.

Protect bare areas during the winter by sowing winter rye at 120 lbs per acre (2.0 lbs/1000 sq. ft.). Seed by September 15 to ensure vegetative cover for winter.

Hydroseeding exposed soil is a good option for stabilizing large areas. Hydroseed is a mixture of seed, fertilizer, water and a tackifier to hold the seed in place before it germinates. Photo courtesy of Hydrograss Technologies.

Seed mixes for wildflower and native plant plots are also available. They are more expensive, but are very hardy, require little mowing or watering, and add beauty to landscaped and other areas. Most mixes require mowing only once per year, to control tree and brush growth.

Suggested seeding rates and other information for various species and seed mixtures				
Seed species & mixtures	**Seed variety**	**Rate in lbs. per acre**	**Per 1000 sq. ft.**	**When and where to use**
Temporary seeding				
Ryegrass (annual or perennial) Winter rye (cereal rye)		20 120	0.5 2.0	Sow May 1 - September 15 Sow September 15 - May 1
Mix #1				
Creeping red fescue Perennial ryegrass	Ensylva, Pennlawn, Boreal Pennfine, Linn	10 10	.25 .25	This mix is used extensively for shaded areas.
Mix #2				
Switchgrass	Shelter, Pathfinder, Trailblazer, or Blackwell	20	.05	This rate is in pure live seed. Good for upland edge of a wetland to filter runoff and provide wildlife benefits. In areas where erosion may be a problem, a companion seeding of sand lovegrass should be added to provide quick cover at a rate of 2 lbs. per acre (0.05 lbs. per 1000 sq.ft.)

Mix #3				
Switchgrass	Shelter, Pathfinder, Trailblazer, or Blackwell	4	.1	This mix has been successful on sand and gravel plantings. It is very difficult to seed without a warm season grass seeder such as a Traux seed drill. Broadcasting this seed is very difficult due to the fluffy nature of some of the seed, such as bluestems and indiangrass.
Big bluestern	Niagra	4	.1	
Little bluestern	Aldous or Camper	2	.05	
Indiangrass	Rumsey	4	.1	
Coastal panicgrass	Atlantic	2	.05	
Sideoats grama	El Reno or Trailway	2	.05	
Wildflower mix		.5	.01	
Mix #4				
Switchgrass	Shelter, Pathfinder, Trailblazer, or Blackwell	10	.25	This mix is salt tolerant, a good choice along the upland edge of tidal areas and roadsides.
Coastal panicgrass	Atlantic	10	.25	
Mix #5				
Creeping red fescue	Ensylva, Pennlawn, Boreal	20	.45	General purpose erosion control mix. Not to be used for a turf planting or play grounds.
Tall fescue	KY - 31, Rebel	20	.45	
Perennial ryegrass	Pennfine, Linn	5	.10	
Birdsfoot trefoil	Empire, Pardee	10	.45	

Good tracking up and down slope. Tracking slows down runoff and promotes infiltration. More mulch is needed.

For slopes steeper than 3:1, walk bulldozer or other tracked vehicle up and down slopes before seeding to create tread-track depressions for catching and holding seed. Mulch slopes after seeding to conserve moisture and provide initial erosion control.

Mulch types and application

Mulch by itself or applied over seed provides excellent erosion protection (see table). To apply, bring site to final grade and clear rocks, wood, trash, and other debris. Apply seed first. Straw or hay should be hand scattered or blown to obtain a depth of 1 inch (see table). In winter, straw or hay mulch should be applied to obtain a depth of 3 inches. Wood chips or shavings should be applied to a depth of 2 inches. In general, apply mulch so that at least 80 to 90 percent of the ground is covered. ***Perform regular maintenance and reapply mulch as needed to ensure bare soil is 80 to 90% covered.**

Stabilize exposed soil with mulch immediately. Excellent application of hay mulch. Good mulch cover and sediment barrier around soil stockpile.

Excellent application of hand-scattered straw mulch in new residential subdivision. Work sites must be seeded and mulched as soon as final grade is established. Crimp mulch into soil with dozer tracking or disk harrows set straight to prevent straw from blowing.

Very good treatment of roadside areas with blown straw after seeding. In areas near lakes, streams, and rivers, straw in roadway must be cleaned up after application.

Mulch Material	Quality Standards	per 1000 sq. ft.	per Acre	Depth of Application	Remarks
Wood chips or shavings	Air-dried. Free of objectionable coarse material	500-900 lbs.	10-20 tons	2-7"	Used primarily around shrub and tree plantings and recreations trails to inhibit weed competition. Resistant to wind blowing. Decomposes slowly.
Wood fired cellulose (partially digested wood fibers)	Made from natural wood usually with green dye and dispersing agent	50 lbs.	2,000 lbs.	–––	Apply with hydromulcher. No tie down required. Less erosion control provided than 2 tons of hay or straw.
Gravel, Crushed Stone or Slag	Washed; Size 2B or 3A –1 1/2"	9 cu. yds.	405 cu. yds.	6"	Excellent mulch for short slopes and high traffic construction areas. Use 2B where subject to traffic. (Approximately 2,000 lbs./cu.yd.). Must be used over filter fabric..
Hay or Straw	Air-dried; free of undesirable seeds & coarse materials	90-100 lbs. 2-3 bales	2 tons (100-120 bales)	2" (cover about 90% surface)	Use small grain straw where mulch is maintained for more than three months. Subject to wind blowing unless anchored. Most commonly used mulching material. Provides the best micro-environment for germinating seeds.

Mulch Material	Quality standards	per 1000 sq. ft.	per Acre	Depth of Application	Remarks
Jute matting	Undyed, unbleached plain weave. Warp 78 ends/yd., Weft 41 ends/ yd. 60-90 lbs./roll	48" x 50 yds. or 48" x 75 yds.	——	——	Use without additional mulch. Tie down as per manufacturers specifications. Good for center line of concentrated water flow.
Excelsior wood fiber mats	Interlocking web of excelsior fibers with photodegradable plastic	8" x 100" 2-sided plastic, 48" x 180" 1-sided plastic	——	——	Use without additional mulch. Excellent for seeding establishment. Tie down as per manufacturers specifications. Approximately 72 lbs./roll for excelsior with plastic on both sides. Use two sided plastic for centerline of waterways.
Compost	Up to 3" pieces, moderately to highly stable	3-9 cu. yds.	130-400 cu. yds.	1-3"	Coarser textured mulches may be more effective in reducing weed growth and wind erosion.
Straw or coconut fiber, or combination	Photodegradable plastic net on one or two sides	Most are 6.5 ft. x 3.5 ft.	81 rolls	——	Designed to tolerate higher velocity water flow, centerlines of waterways, 60 sq. yds. per roll.

Erosion control blankets

Erosion control blankets are used to protect steep slopes (up to 3:1; check product information sheets), drainage ditches with less than 20:1 slopes, and other areas where erosion potential is high. Most are designed to provide temporary stabilization until vegetation is established. Blankets degrade within 6 to 24 months, depending on their makeup. They usually consist of a layer of straw, coconut fiber, wood fiber, or jute sandwiched between layers of plastic or fiber mesh.

For short slopes (8 feet or less) above channels, install blankets across the slope (horizontal). Install up and down the hill (vertical) for long slopes.

Install blankets and mats vertically on long slopes. Unroll from top of hill, staple as you unroll it. Do not stretch blankets.

Excellent use of erosion control matting. Make sure to walk erosion control rolls downhill and secure with staples as per manufacturer instructions. Remember to trench matting in at top of hills.

Walk blankets down to ensure good contact with the soil. Use plenty of staples to keep blankets flat. Overlap blankets at 6 to 8 inches on sides, tops, and bottoms. Do not stretch blankets, and do not exceed manufacturer's directions on maximum slope angle for the product.

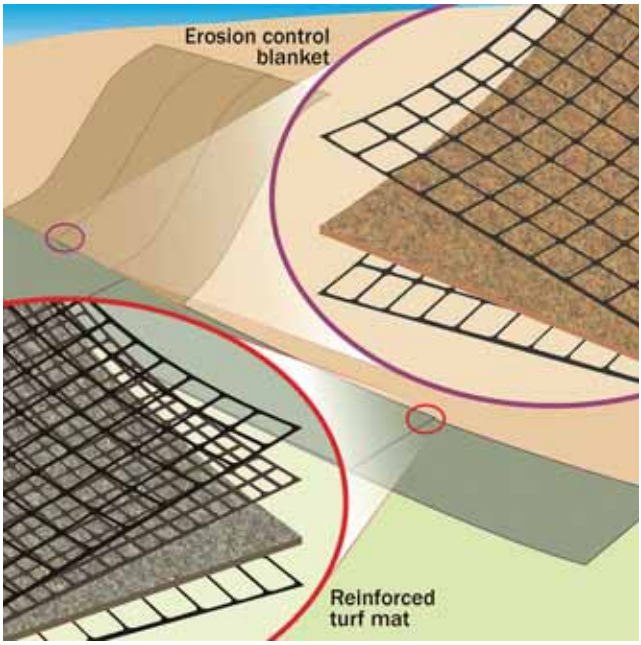
Site conditions	Blanket installation notes
Ditches and channels (from high flow line to ditch bottom—see Section 8)	• Grade, disk, and prepare seedbed. • Seed the area first • Install horizontally (across slope). • Start at ditch bottom. • Staple down blanket center line first. • Staple & bury top in 8 inch deep trench. • Uphill layers overlap bottom layers. • Side overlap should be 6–8 inches. • Staple thru both blankets at overlaps. • Follow manufacturer's specifications.
Long slopes, including areas above ditch flow levels	• Grade, disk, and prepare seedbed. • Seed the area first. • Install vertically (up & down hill). • Walk down from top of hill. • Staple down center line of blanket first. • Staple & bury top in 8 inch deep trench. • Uphill layers overlap downhill layers. • Overlaps should be 6–8 inches. • Staple thru both blankets at overlap. • Follow manufacturer's specifications.

Blankets installed along stream banks or other short slopes can be laid horizontally. Install blankets vertically on longer slopes. Ensure 6 inch minimum overlap.

Excellent soil coverage at stabilization project using hand scattered straw, jute matting, and erosion blanket.

Very good installation of erosion control blanket in seeded ditch below well-mulched slope on highway project.

Good application of erosion control blanket to stabilize shoulder and protect storm drain, but too few staples used along the top edge. Trench in top edge of blanket on steep slopes.



Erosion control blankets are thinner and usually degrade quicker than turf reinforcement mats. Check manufacturer's product information for degradation rate (life span), slope limitations, and installation. Prepare soil and seed before covering with blankets or mats!

Turf reinforcement mats

Turf reinforcement mats are similar to erosion control blankets, but are thicker and sturdier because they have more layers and sturdier fill material. Mats provide greater protection than blankets because of their heavier construction, and last longer in the field.

Mats are used for steep slopes (3:1 or steeper) and ditches or channels with 15:1 to 10:1 slopes. Mats are installed just like blankets (see previous table). Additional staking or stapling is needed for applications in channels that carry flowing water, and on steep slopes.

Sod application

Sod reduces the potential for erosion to near zero. To install, bring soil to final grade and clear of trash, wood, rock, and other debris. Test soil, apply topsoil and fertilize in accordance with soil test results.

Use sod within 36 hours of cutting. Lay sod in straight lines. Butt joints tightly, but do not overlap joints or stretch sod. Stagger joints in adjacent rows in a brickwork type pattern. Use torn or uneven pieces on the end of the row. Notch into existing grass.

On sloping areas where erosion may be a problem, sod shall be laid with the long edges parallel to the contour and with staggered joints. Roll or tamp sod after installation and water immediately. Soak to a depth of 4 to 6 inches.

Replace sod that grows poorly. Do not cut or lay sod in extremely wet or cold weather. Do not mow regularly until sod is well established.

Bonded Fiber Matrices

Installing sod immediately after grading work is complete can reduce erosion and sediment loss to near zero.

Other engineered products are available that are similar to blankets and mats. For example, bonded fiber matrices and other hydraulically applied products contain a mix of soil binders, mulch fibers, and even seed and fertilizer that can provide a stable crust that cements soil particles and prevents erosion. Apply seed prior to hydraulic mats or mulches, if seed is not included in the mix. Consult the manufacturer's installation instructions for product applicability and installation instructions.

SECTION 5

Using Silt Fence and Other Sediment Barriers

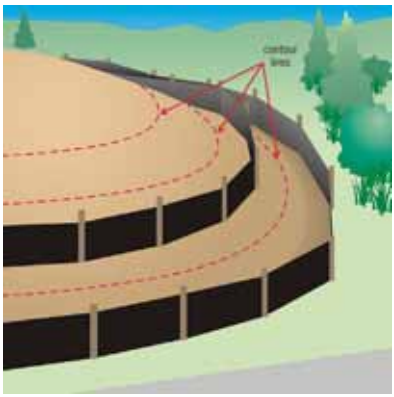
The use of silt fences and other sediment barriers involves simple observation and common sense. However, as Will Rogers once noted, “common sense ain’t so common.” The following practices may be used as interchangeable sediment barriers.

	Condition where practice applies		
Interchangeable Practices	Downhill edge of bare soil	Across disturbed area	Around stockpiles
Silt Fence	x	x	x
Perimeter Dike & Swale	x	x	x

Sediment barrier placement

Sediment barriers are required below (downhill from) areas of bare soil. Hay or straw bales must not be used as sediment barriers due to their inherent weakness and tendency to fall apart. There are several factors to consider in placing silt fences or perimeter dikes and swales:

- Place barriers on downhill edge of bare soil areas.
- Make sure the barrier catches all the runoff.
- The goal is to intercept runoff and settle sediment out.
- Install multiple sediment barriers on long slopes.
- Put barriers across slopes, on the contour (level).



Silt fences should be installed on the contour below bare soil areas. Use multiple fences on long slopes. Remove accumulated sediment before it reaches halfway up the fence.

Silt Fence

Each 100-foot section of silt fence can intercept runoff from about ¼ acre. To install a silt fence correctly, follow these steps:

- Note the location & extent of the bare soil area.
- Mark silt fence location just below bare soil area or 10 feet below the bottom of a steep slope.
- Make sure fence will catch all flows from area.
- Place fence across the slope.
- Dig trench 6 inches deep and 4 inches wide.
- Unroll silt fence along trench.
- Join fencing by rolling the end stakes together.
- Make sure stakes are on downhill side of fence.
- Drive stakes in against downhill side of trench.
- Drive stakes until 16 inches of fabric is in trench.
- Push fabric into trench; spread along bottom.
- Fill trench with soil and tamp down.

Silt fencing should not be installed:

- Up and down hills.
- Above (uphill from) areas of bare soil.
- In ditches, channels, or streams.
- In stream buffers.
- Directly at the toe (bottom) of the slope. Additional storage capacity is needed and can be provided for by placing the fence 10 feet below toe. (Place fence directly at toe if near water or stream buffer)

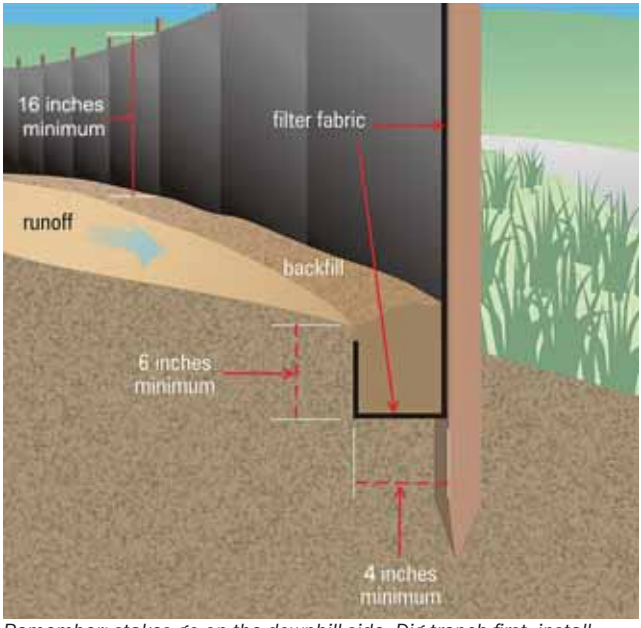
If runoff flows along the uphill side of a silt fence, install "J-hooks" every 40 to 80 feet. These are curved sections of silt fence that act as small dams to stop, pond, and settle out flows.

Use J-hooks to trap runoff flowing along uphill side of silt fence. Turn ends of silt fence toward the uphill side to prevent bypassing. Use multiple J-hooks every 40 to 80 feet for heavier flows.

Very good installation of multiple silt fences on long slope. Turn ends of fencing uphill to prevent bypass. Leave silt fences up until grass is well established on all areas of the slope. Re-seed bare areas as soon as possible. Remove or spread accumulated sediment and remove silt fence after all grass is up.

Maximum allowable slope lengths contributing runoff to a silt fence placed on a slope

Slope Steepness	Maximum Length (feet)
2:1	25
3:1	50
4:1	75
5:1 or flatter	100



Remember: stakes go on the downhill side. Dig trench first, install fence in downhill side of trench, tuck fabric into trench, then backfill on the uphill side (the side toward the bare soil area).

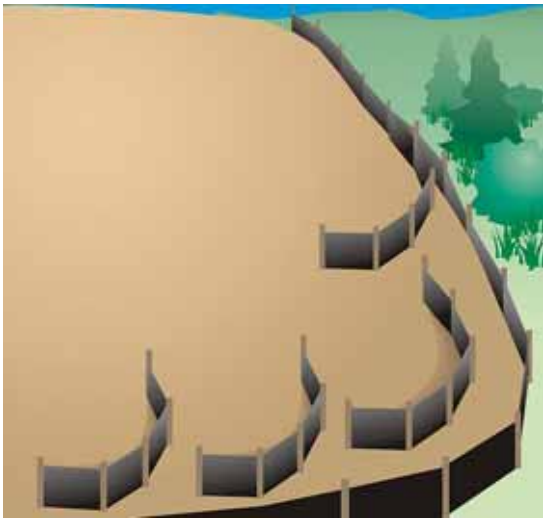
Excellent example of J-hook installation to intercept muddy runoff flowing along silt fence. Good temporary seeding and mulching (right side).

Tractor mounted silt fence slicing devices cut a slit into the ground and push fabric in. Installation is quicker and performance is better than the open trench method, making this approach attractive for large sites.

Silt fence slicing devices

New tractor-mounted equipment that "slices" silt fence into the ground can provide a better installation than the open trench method. The equipment uses a chisel-point or vibratory plow to create a narrow slit in the ground. Rolled silt fencing is pushed into the slit, creating a very tight seal that prevents water from blowing out the bottom of the fence. Posts are driven and attached to the fence after the fencing is installed.

Besides better performance, the slicing method is also faster. For slicing and all other applications, posts are spaced 6 feet apart or less.



Silt fences don't have to be on the property line. Placing them on slopes with the ends turned up to trap sheet flow provides better performance. Stagger fence sections to ensure total coverage. Clean out before sediment reaches halfway up. Repair as needed, and remove when grass is well established.

Very good use of continuous "super" (reinforced) silt fence. Note that wire fencing is installed between the filter fabric and the posts.

Good use of J-hook in silt fence to trap sediment in water running along fence. Sediment must be removed before it reaches halfway to top of fence.

Sediment barrier installed backwards. Silt fence fabric should face bare soil area. Stakes go on downhill side. Straw bales can be used to back up fence on downhill side, but not alone.

Very poor attention to silt fence maintenance. Fences and other sediment controls must be inspected and repaired weekly; activities should be logged.

Poor sediment filter installation, no curb inlet protection. Bales alone provide poor protection (note mud on pavement). Very good seed application.

Good installation of silt fence at toe of slope. Do not pile soil or other material on silt fences! Also, if space is available move fence back from toe of slopes to allow room for sediment accumulation and maintenance. Leaving a strip of vegetation between bare soil and fence also improves performance.

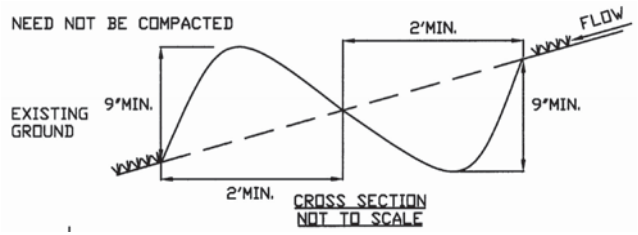
Poor installation where silt fences are joined. Roll end stakes together before driving in to create an unbroken sediment barrier or lap curved sections to prevent bypasses. Leaving grass strip between silt fence and bare soil area is a good idea.

Poor installation of silt fencing, fair to good seeding. Silt fence must be trenched in along bottom. Straw bales are not approved as sediment barriers.

Perimeter Dike and Swale

A perimeter dike is a temporary ridge of soil excavated from an adjoining swale located along the perimeter of the site or disturbed area. The purpose of a perimeter dike and swale is to prevent off site storm runoff from entering a disturbed area and to prevent sediment laden storm runoff from leaving the construction site or disturbed area.

Perimeter Dike and Swale Detail



Perimeter Dike and Swale Design Criteria

Drainage area - less than 2 acres
Height - 18 inches minimum
(measure from bottom of swale to top of dike)
Bottom width of dike - 2 feet minimum
Width of swale - 2 feet minimum
Grade - not to exceed 8%. Swale shall have positive drainage to a stabilized outlet.

Construction Specifications

1. Stabilize the dike and swale within 48 hours of installation.
2. Install berm on the contour (along the slope).
3. Diverted runoff from a stabilized upland area shall outlet directly onto an undisturbed, stabilized area at a non-erosive velocity.
4. Diverted runoff from a disturbed upland area shall be conveyed to a sediment trapping device.

SECTION 6

Protecting Slopes to Prevent Gullies

Slopes—especially long ones—must be protected to prevent sheet, rill, and gully erosion. Slopes must be stabilized immediately after grading work is completed. The following practices can be used interchangeably to protect and stabilize slopes:

	Condition where practice applies			
Interchangeable practices	Slope Steepness			
	< 33%	33 - 50%	50 - 80%	> 80%
Erosion Control Blankets and Mats	x	x		
Hydraulic Mulch	x	x		
Rock Gabions			x	x
Riprap slope protection		x	x	

Approximate slope conversions

Percent	Slope ratio	Degrees
100%	1:1	45°
50%	2:1	27°
33%	3:1	18°
25%	4:1	14°
10%	10:1	6°

The following practices are included in this section for informational purposes only. Consult the EPSC Plan designer or engineer for design and installation specifications.

Pipe Slope Drain • Subsurface Drain • Lined Waterway • Engineered Terracing • Surface Roughening • Retaining Wall • Fiber Roll

Assessing slopes and soils

Steeper slopes (3:1 or steeper) require more protection than flatter slopes. Slopes with highly erodible soils (silty soils) need more protection than those with less erodible soils (sands and gravels). Also, long slopes (greater than 50 feet) are at greater risk for erosion than short slopes.

Slope protection basics

Protecting slopes from erosion requires several actions that must be taken together. No single approach will be successful, especially if the slope is long, steep, or has highly erodible soils. Use one or more of the following actions to reduce erosion on slopes:

Divert upland runoff

See Section 3 for information on how to install a berm or channel above the slope to divert upland rain runoff around the bare soil area.

Control slope runoff

If slopes are broken up into benches or steps, runoff can be collected and diverted along berms or in channels to pipe or open channel slope drains with stable outlets.

Till seedbed or condition the soil

Dozer tracks up and down slopes help hold soil in place and lengthen the runoff flow path down the slope. See Section 4 for information on how to condition of the soil surface.

Seed and mulch

The best and cheapest protection by far. See Section 4 for details on seed types, application rates, and mulch, blanket, and mat products.

Silt fence or other barrier

These should be installed at the toe of the slope or slightly away from the toe. Multiple fences should be installed on long slopes. Fiber rolls installed on the contour work very well in breaking up flows on long slopes.

Retaining wall

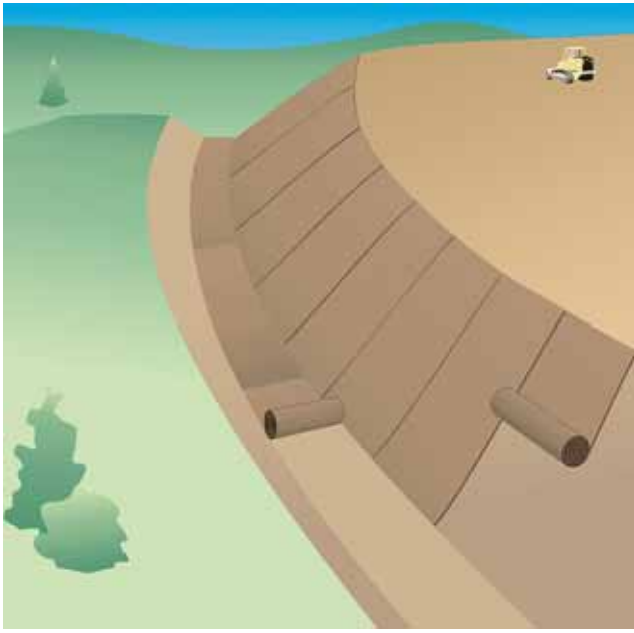
Extremely steep slopes can be leveled out and shortened into two or more steps or benches by installing retaining walls of rock, brick, block, wood, logs, or other material. If rock layers are present along the slope, use these to establish firm benches in a stair-step pattern.

Blankets, mats, or armoring

Slopes exceeding 3:1 with highly erodible soils must be protected with turf reinforcement mats or other products such as hydraulic soil binders or bonded fiber matrices. Rock mulch and lined downdrain channels might be needed on steep slopes to control gullying.

Erosion Control Blankets and Mats

Steep slopes can be protected with erosion control mats and blankets. Erosion control matting and blankets are appropriate for slopes up to a 3:1 steepness. For slopes greater than 3:1, use turf reinforcement mats. (See Section 4 for installation details).



Steep, long slopes need blankets or mats. Install blankets and mats up and down long slopes. For channels below slopes, install horizontally. Don't forget to apply seed, lime, and fertilizer (if used) before installing blanket.

Excellent slope protection with seeding and erosion control blanket. Blankets or mats are required on most projects if slopes are 3:1 or steeper.

Hydraulic mulch

Bonded fiber matrices and hydraulic mulch can be very effective in controlling erosion on slopes. Hydraulic mulch applied after seeding or with seed in the mix can provide permanent protection if mixed and applied properly. (See Section 4 for details)

Rock Gabions

Rock Gabions are wire 'baskets' filled with rock used to permanently stabilize slopes. Gabion baskets should be filled with 4 - 8 inch stone and layered according to manufacturers recommendations.

Good use of rock-filled, stacked gabion baskets to protect steep slope. Soil and bark mulch can be used in or over gabions and planted with live willow or hardwood cuttings to reduce "hardened" look.

Very poor slope protection. For best results, prepare soil and apply seed with mulch or blanket immediately after reaching final grade.

Riprap Slope Protection

Riprap is a layer of stone designed to protect and stabilize areas subject to erosion. Riprap is used in areas where vegetation cannot be established. Follow your EPSC Plan design specifications for installation.

Good use of riprap on a steep roadside slope. Use the appropriate sized rock for the slope steepness to avoid rock slides.

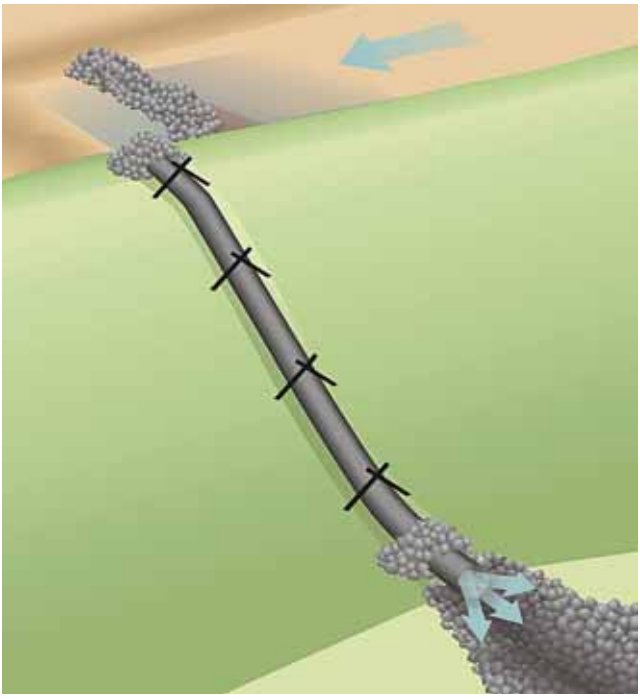
Additional Practices for Protecting Slopes

The following practices are included in this section for informational purposes only. Consult the EPSC Plan designer or engineer for design and installation specifications.

Pipe Slope Drain

A pipe slope drain is a temporary structure placed from the top to the bottom of a slope to convey runoff down the slope without causing erosion.

Good use of multiple pipe slope drains to prevent erosion while vegetation establishes.



Temporary downdrain using plastic pipe. Stake down securely, and install where heavy flows need to be transported down highly erodible slopes. Note silt check dam in front of inlet.

Very good use of 20-inch plastic slope drain pipes to convey water from roadway to lower channel. Note staking and rock anchoring at bottom of temporary slope drain pipes.

Subsurface Drain

A subsurface drain is a conduit, such as a tile, pipe, or tubing installed beneath the ground surface that intercepts, collects, and/or conveys drainage water.

A subsurface drain safely conveys water down a slope to prevent erosion. Ensure to install the drain outlet to prevent scour and erosion.

Stone Lined Waterway

A stone lined waterway is a channel that carries water down a slope to prevent slope erosion or gullying.

Very good application of rock lined downdrain channel to carry water down slope face. Use filter fabric under rock. Install multiple drains at appropriate spacing where flows are heavy. Install flow dissipaters at outlet to absorb energy of the discharge.

Engineered Terracing

Terracing is the reshaping of the existing land surface to control erosion and promote the establishment of vegetation.

Good use of engineered terracing to reduce erosion on this steep roadside slope.

Surface Roughening

Roughening bare soil by creating horizontal grooves across a slope, stair-stepping, or tracking with construction equipment aids in seed establishment, reduces runoff velocity, increases infiltration, and reduces erosion by trapping water and sediment.

Tread-track slopes up and down hill to improve stability.

Retaining Wall

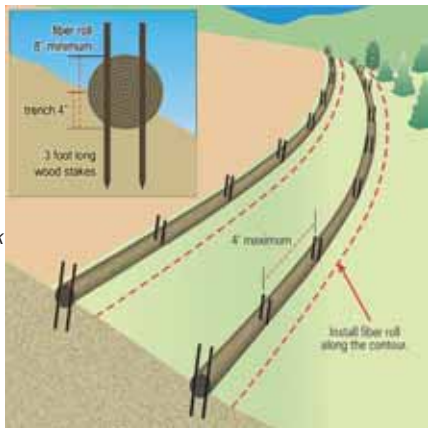
A retaining wall is constructed against a slope to prevent soil movement. It retains soil in place and prevents slope failures and movement of material down steep slopes.

Retaining walls can be built from mortared block or stone, cast-in-place concrete, railroad ties, gabions, and precast, modular, segmented walls. The design of any retaining wall structure must address the aspects of foundation bearing capacity, sliding, overturning, drainage, and loading systems. These are complex systems and all but the smallest retaining walls should be designed by a licensed engineer.

Good use of engineered retaining wall to break up slope. Development site and customer preferences will dictate type of materials used.

Fiber Roll

A fiber roll is a woven roll of coconut fiber, straw, or excelsior encased in a netting of jute, nylon, or burlap. Fiber rolls can be used to break up runoff flows on long slopes.



Fiber rolls help to break up runoff flows on long slopes. They should be Installed on the contour and according to manufacturer's specifications.

SECTION 7

Protecting Culvert and Ditch Inlets and Outlets

Culverts and ditches are designed to carry moderate and large flows of storm water. They can transport a lot of sediment to streams, rivers, wetlands, and lakes if they are not properly protected. In addition, culvert and ditch outlets can become severely eroded if high velocity flows are not controlled.

Culvert and storm drain ponding methods

Muddy runoff that flows toward a culvert, ditch, or storm drain inlet must be slowed down and pooled to settle out and remove sediment. This can be accomplished by placing rock, reinforced silt fencing, silt dikes, or other barrier in front of the inlet. The goal is to cause ponding of the inflow so sediment can settle out, and allow ponded water to enter the inlet only after sediment has been removed.

Straw bales alone are not approved for inlet protection. The maximum drainage area above the inlet protection device is one acre. For all inlet protection approaches, seeding and/or mulching upland areas promptly will greatly reduce incoming runoff volumes and sediment loads. **The drainage area for storm drain inlets shall not exceed one acre.** All inlet protection practices should be inspected after storm events and repaired as necessary. Accumulated sediment should be removed when 50% of ponding volume is lost.

The following are interchangeable practices for inlet protection:

	Condition where practice applies		
Interchangeable Practices	Drainage area ≤ 1 acre	Slope around inlet	
		< 1%	> 1%
Excavated drop inlet protection	x	x	x
Fabric drop inlet protection	x	x	
Stone & Block drop inlet protection	x	x	x
Curb drop inlet protection	x	x	x

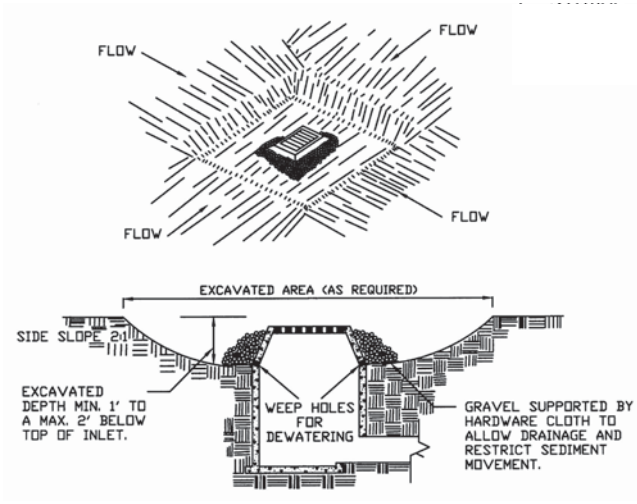
Excavated drop inlet protection

Side slopes - maximum steepness 2:1
Depth - minimum 1 foot; maximum 2 feet

Shape the excavated basin to fit conditions with the longest dimension oriented toward the longest inflow area to provide maximum trap efficiency. The capacity of the excavated basin, below the level of the grate, should be established to contain 900 cubic feet per acre of disturbed area. Weep holes, protected by fabric and stone, should be provided for draining the temporary pool.

Inspect and clean the excavated basin after every storm. Sediment should be removed when 50 percent of the storage volume is lost.

Excavated drop inlet protection detail



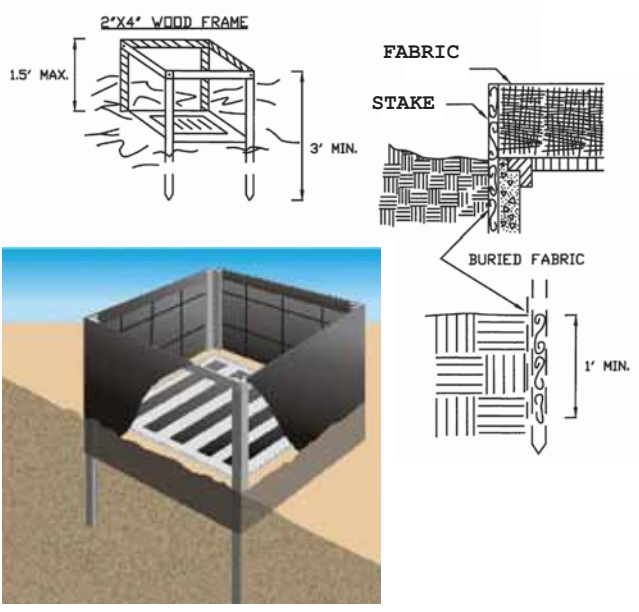
Poor protection for drop inlet on concrete pad. Straw bales make good mulch but are not suited for inlet protection or silt check dams.

Filter fabric drop inlet protection

Slope around device - Not to exceed 1%
Height of fabric - 1.5 feet max., (unless reinforced). The top of the barrier should be maintained to allow overflow to drop into the drop inlet and not bypass the inlet to unprotected lower areas.
Support stakes - 3 feet min., spaced max 3 feet apart; Stakes should be driven close to the inlet so overflow drops into the inlet and not on the unprotected soil.

1. Filter fabric shall have an equivalent opening size (EOS) of 40-85.
2. Cut fabric from a continuous roll to eliminate joints.
3. Stakes will be standard 2 x 4 inch wood or metal with a minimum length of 3 feet.
4. Space stakes evenly around inlet, 3 feet apart and 18 inches deep. Spans greater than 3 feet should be reinforced with wire mesh.
5. Fabric shall be embedded at least 1 foot in ground and backfilled. It should be secured to the stakes.
6. A 2 x 4 inch wood frame shall be completed around the crest of the fabric for overflow stability.

Filter Fabric drop inlet protection detail



Use wire fence backing to reinforce frame, or diagonal bracing across top of stakes. Make sure fence is trenched in to prevent bypasses or undercutting. Inspect and remove sediment as necessary after each rain.

Stone and block drop inlet protection

Height - 1 foot min., 2 feet max. Limit the height to prevent excess ponding and bypass flow.

Block placement - Recess the first row of blocks at least 2 inches below the top of the storm drain for lateral support. Blocks can also be supported by placing a 2x4 inch wood stud through the block openings perpendicular to the row. The bottom row should have a few blocks oriented so flow can drain through the block to dewater the basin area.

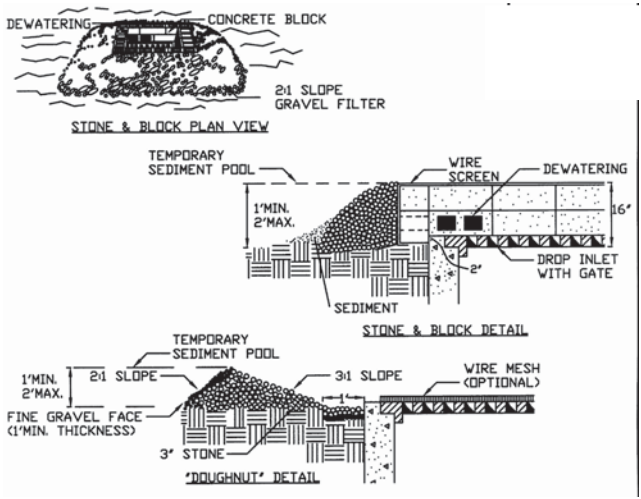
Stone placement - Place stone just below the top of the blocks on slopes of 2:1 or flatter. Place hardware cloth of wire mesh with ½ inch openings over all block openings to hold stone in place.

Optional "doughnut" design - The concrete blocks may be omitted and the entire structure constructed of stone, ringing the outlet. The stone should be kept at a 3:1 slope toward the inlet to keep it from being washed into the inlet. A level area 1 foot wide and four inches below the crest will further prevent wash.

Stone size for "doughnut" - At least 3 inches closest to the inlet, for stability; 1 inch or smaller around the larger rock to control flow rate.

Elevation for "doughnut" - The top of the stone should be 6 inches lower than the ground elevation down slope from the inlet to ensure that all storm flows pass over the stone into the storm drain and not past the structure. Temporary diking should be used as necessary to prevent bypass flow.

Stone and Block drop inlet protection



Very good design and installation of inlet protection ponding dam using concrete blocks and rock. Outlet pipe in background has a rock apron to dissipate flows.

Very good application of mixed rock for culvert inlet ponding dam. Mixing rock promotes better ponding, drainage, and settling of sediment.

Straw bales have rotted and failed, with muddy runoff undercutting bales. Concrete apron and drop inlet grate are nearly covered in sediment. Use straw for mulch only.

Curb drop inlet protection

Stone size - 2 inches

Wire mesh - of sufficient strength to support the filter fabric and stone with the water fully impounded against it.

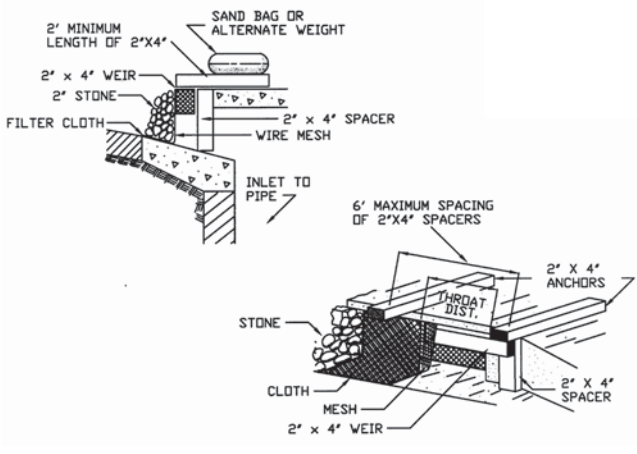
Filter fabric - type approved for this purpose with an equivalent opening size (EOS) of 40-85.

Length of structure - must extend beyond the inlet 2 feet in both directions.

Assure that storm flow does not bypass the inlet by installing temporary dikes (such as sand bags) directing flow into the inlet. Make sure that the overflow weir is stable. Traffic safety shall be integrated with the use of this practice.

The structure should be inspected after every storm event. Any sediment should be removed and disposed of on the site. Any stone missing should be replaced. Check materials for proper anchorage and secure as necessary.

Curb drop inlet protection detail



Excellent use of concrete blocks and #57 rock for ponding dam to protect inlet. Note 2x4 inch board through blocks for stabilization. Note galvanized fencing and filter fabric between block and rocks.

Poor placement of stone bag inlet dam; poor education of construction site drivers. Bags work well if used properly and maintained. Bags must form a dam around the inlet with no large gaps.

Poor placement and poor maintenance of stone bag inlet ponding dam. Accumulated sediment must be removed and dam should be repaired after each half-inch rain.

Outlet protection methods

Outlets for storm drains, culverts, and paved channels that discharge into natural or constructed channels must be lined with rock or other armoring to prevent downstream bank and channel erosion when flow velocities are high.

The following practices are included in this section for informational purposes only. Consult the EPSC Plan designer or engineer for design and installation specifications.

- Rock Outlet Protection
- Paved Flume
- Level Spreader

Rock outlet protection

Rock placed at the end of culvert reduces the depth, velocity, and energy of water, such that the flow will not erode the receiving downstream reach.

Good placement and construction of rock apron at high-flow culvert outlet. If flow from culvert enters a channel, make sure channel is lined with grass, and blankets or mats, if necessary, to prevent erosion.

Paved Flume

A paved flume is a small concrete-lined channel designed to convey concentrated runoff safely down the face of a relatively steep slope without causing erosion.

Level Spreader

A level spreader is a non-erosive outlet designed to convert concentrated flow to sheet flow and release it uniformly over a stabilized area.

Rick McLaughlin, NCSU

USACE-Chicago

SECTION 8

Stabilizing Drainage Ditches

Stabilizing drainage ditches helps to provide for the safe transport of excess surface water from the construction sites and urban areas without damage from erosion.

This section is divided into 3 parts:

- Vegetating Low Grade Channels,
- Protecting Steep Channels, and
- Installing Check Dams

Interchangeable practices are provided for Vegetating Channels and Installing Check Dams. Practices for Protecting Steep Channels are included in this section for informational purposes only. Consult the EPSC Plan designer or engineer for design and installation specifications for steep channel protection.

Vegetating Low Grade Channels

Vegetating drainage channels helps to reduce the velocity of the channelized runoff and limit the erosion potential. The following practices can be used interchangeably to vegetate low grade channels.

	Condition where practice applies	
Interchangeable Practices	Slope	
	≤ 10%	10 - 33%
Seed and Mulch	x	
Rolled Erosion Control Products	x	x
Sod	x	x

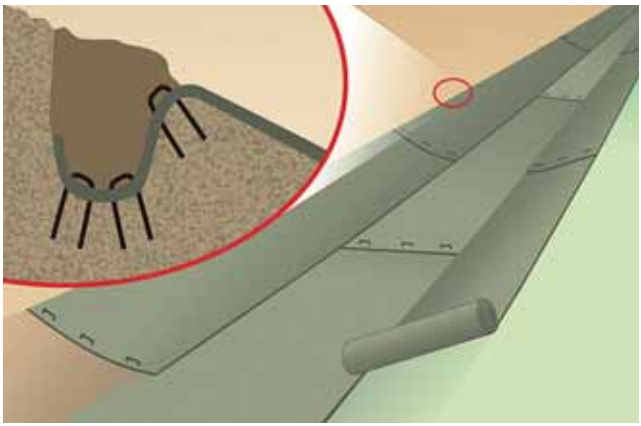
Seed and Mulch

To establish vegetation in a channel, seed and mulch using the guidance in Section 4. Prepare the soil for seeding and ensure that vegetation is well established before water is diverted to the channel.

Rolled Erosion Control Products (RECPs)

Rolled Erosion Control Products (RECPs) include erosion control mats, turf reinforcement mats, and jute and excelsior matting. RECPs should be used in channels with flow velocities up to 3.5 feet/sec. See Section 4 for installation instructions and seeding information.

Good use of jute and excelsior matting to stabilize the channel. Rolled Erosion Control Products reduce erosive velocities and help vegetation establish.



Lay in ditch blankets similar to roof shingles; start at the lowest part of the ditch, then work your way up. Uphill pieces lap over downhill sections. Staple through both layers around edges. Trench, tuck, and tamp down ends at the top of the slope. Do not stretch blankets or mats.

Sodding

Sod can also be used in low grade channels to reduce runoff velocities and minimize erosion potential. See Section 4 for sod installation instructions and specifications.

Protecting Steep Channels

Channels with grades steeper than 3:1 may need additional armoring to prevent downcutting and erosion.

The following practices are included in this section for informational purposes only. Consult the EPSC Plan designer or engineer for design and installation specifications.

- Rock Lining
- Grade Stabilization Structure

Rock Lining

Riprap lined channels provide for the transport of concentrated runoff without damage from erosion, where vegetated channels would be inadequate due to high velocities.

Grade Stabilization Structure

Grade stabilization structures control head cutting in natural or man made channels. They are designed to limit erosion by reducing velocities and grade in the watercourse.

Installing Check Dams

Drainage ditches need temporary check dams to capture sediment and reduce ditch bottom downcutting. The following are interchangeable types of check dams.

	Condition where practice applies
Interchangeable Practices	Drainage area < 2 acres
Rock Check Dam	x
Fiber Rolls	x
Sand Bags	x

Silt fencing and hay bales are not approved for use as check dams, and must not be used in drainage ditches that carry flowing water. Also, do not place dams in creeks or streams. Sediment must be intercepted before it reaches streams, lakes, or wetlands.

Design Criteria

Drainage Area: Maximum 2 acres

Height: No greater than 2 feet. Center of dam should be 9 inches lower than the side elevation

Side slopes: 2:1 or flatter

Spacing: Space the dams so that the bottom (toe) of the upstream dam is at the elevation of the top (crest) of the downstream dam. This spacing is equal to the height of the check dam divided by the channel slope.

$$\text{Spacing (in feet)} = \frac{\text{Height of check dam (in feet)}}{\text{Slope in channel (ft/ft)}}$$

Check dams should be anchored in the channel by a cutoff trench 1.5 feet wide and 0.5 feet deep and lined with filter fabric to prevent soil migration.

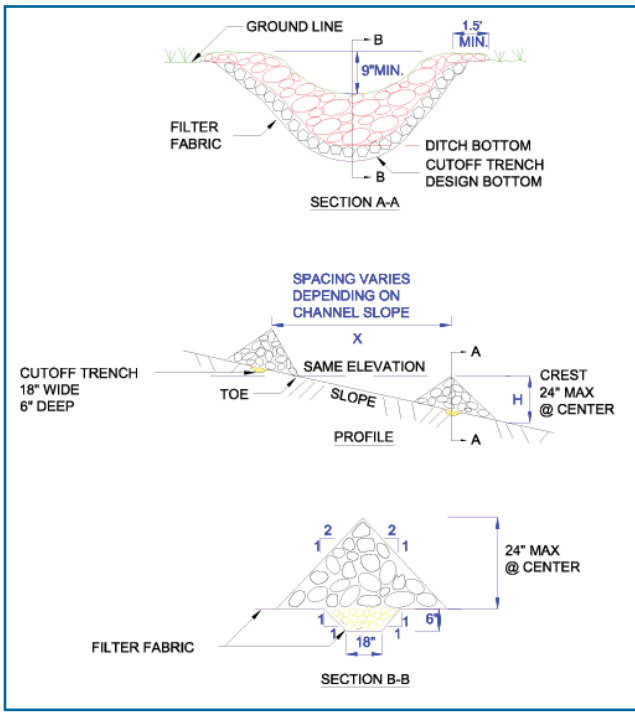
Maintenance: Check dams should be inspected after each runoff event. Correct all damage immediately. If significant erosion has occurred between structures, a liner of stone or other suitable material should be installed in that portion of the channel.

Remove sediment accumulated behind the dam as needed to allow channel to drain through the check dam and prevent large flows from carrying sediment over the dam. Replace stone, fiber roll, or sand bags as needed to maintain the design cross section of the structures.

Rock Check Dams

Stone size: Use a well graded matrix of 2 to 9 inch stone

X (spacing) = Height of check dam (in feet) / Slope in channel (ft/ft)



Good installation of temporary rock silt checks. Remember to tie sides of silt check to upper banks. Middle section should be lower. Clean out sediment as it accumulates. Remove silt checks after site and channel are stabilized with vegetation.

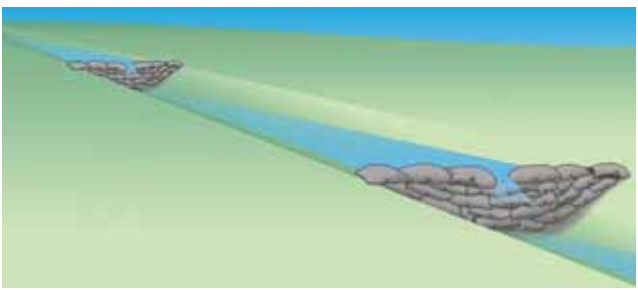
Fiber Rolls

Fiber rolls may be used as check dams if they are keyed into the banks, securely fastened in the channel, and the centers are 9 inches lower than the side elevations. Follow the spacing and installation instructions for "Installing Check Dams".

Good placement and spacing of fiber-roll silt checks. Coconut fiber rolls and other commercial products can be used where ditch slopes do not exceed three percent.

Sand Bag Check Dams

Sand bags may also be used to form check dams. Follow the installation and spacing instructions in "Installing Check Dams" at the beginning of this section.



Check dams of rock, fiber roll, or stone-filled bags must be installed before uphill excavation or fill activities begin. See formula for correct check dam spacing. Tied end of bag goes on downstream side.

Hay bales must not be used as check dams due to their high failure rates.

Poor application of commercial check dam product. Commercial products are not approved for use as check dams.

Poor silt check installation. Straw bales are not approved as check dams for ditch or channel applications due to rotting, installation difficulties, and high failure potential.

SECTION 9

Winter Requirements

Managing construction sites to minimize erosion and prevent sediment loading of waters is a year-round challenge. In Vermont, this challenge becomes even greater during the late fall, winter, and early spring months.

'Winter construction' as discussed here, describes the period between October 15 and April 15, where the erosion prevention and sediment control is significantly more difficult.

Rains in late fall, thaws throughout the winter, and spring melt and rains can produce significant flows over frozen and saturated ground, greatly increasing the potential for erosion. At the same time as the erosion risk increases, the "toolbox" available to the planner and on-site plan coordinator shrinks significantly.

In particular, establishing vigorous vegetation during winter construction is difficult if not impossible in most areas of the state. How a site addresses winter conditions depends upon the nature of the construction activities over this period.

Effects of Winter on EPSC Practices

EPSC Measure	Effect of Winter Conditions
Vegetative Ground Cover	Cannot be established outside of growing season.
Hydroseeding	Stabilizers are poor in cold conditions, poor/no growth of seed cover.
Diversion Structures	Difficult or impossible to implement in frozen soils.
Sedimentation Basins	Must be installed pre-ground freezing. Can be overwhelmed by spring flows.
Silt Fence	Difficult to install in frozen ground. Often fail during spring melt.
Erosion Blankets	Cannot be installed correctly on frozen ground. Improper installations wash away in melt flows.
Grassed Lined Swales	Installation following ground freezing is difficult, leaving unprotected concentrated flows with significant erosion as a result.
Impervious Stabilization	Paving, other measures cannot be completed in winter.

Requirements for Winter Shutdown

For those projects that will complete earth disturbance activities prior to the winter period (October 15), the following requirements must be adhered to:

1. For areas to be stabilized by vegetation, seeding shall be completed no later than September 15 to ensure adequate growth and cover.

2. All non-vegetative stabilization must be completed by October 15.

3. Where mulch is specified, apply roughly 3 inches with an 80-90% cover. Mulch should be tracked in or stabilized with netting in open areas vulnerable to wind.

Stabilization and seeding of slopes before winter will reduce or eliminate erosion in the spring. The grass on this slope is holding the soil in place and promoting infiltration of the melting snow.

Requirements for Winter Construction

If construction activities involving earth disturbance continue past October 15 or begin before April 15, the following requirements must be adhered to:

1. Enlarged access points, stabilized to provide for snow stockpiling.

2. Limits of disturbance moved or replaced to reflect boundary of winter work.

3. A snow management plan prepared with adequate storage and control of meltwater, requiring cleared snow to be stored down slope of all areas of disturbance and out of stormwater treatment structures.

4. A minimum 25 foot buffer shall be maintained from perimeter controls such as silt fence.

5. In areas of disturbance that drain to a water body within 100 feet, silt fence shall be replaced with perimeter dikes, swales, or other practices resistant to the forces of snow loads.

6. Drainage structures must be kept open and free of snow and ice dams.

7. Silt fence and other practices requiring earth disturbance must be installed ahead of frozen ground.

8. Mulch used for temporary stabilization must be applied at double the standard rate, or a minimum of 3 inches with an 80-90% cover.

9. To ensure cover of disturbed soil in advance of a melt event, areas of disturbed soil must be stabilized at the end of each work day, with the following exceptions:

   - If no precipitation within 24 hours is forecast and work will resume in the same disturbed area within 24 hours, daily stabilization is not necessary.

   - Disturbed areas that collect and retain runoff, such as house foundations or open utility trenches.

10. Prior to stabilization, snow or ice must be removed to less than 1 inch thickness.

11. Use stone to stabilize areas such as the perimeter of buildings under construction or where construction vehicle traffic is anticipated. Stone paths should be 10—20 feet wide to accommodate vehicular traffic.

SECTION 10

Closing Out Your Construction Project

When construction is complete you must finish final grading and stabilize the site. Once the site is stabilized, clean out and remove all temporary sediment controls.

Final site stabilization

Make sure all subcontractors have repaired their work areas prior to final closeout. Conduct a final inspection of all work areas, vegetation, stormwater flow structures, and downstream receiving waters to make sure no visible gullies or sediment movement is evident. Notify site owner or manager after all temporary erosion and sediment controls have been removed and final stabilization has been completed. If the site is one acre or larger and covered under a VT Storm Water Permit, submit a Notice of Termination to the VT Stormwater Section (see dec.vermont.gov/watershed/stormwater).

Vegetated cover considerations for close-out

No site is closed out properly until vegetation is established on all bare soil areas and ditches are stable. Check seeded areas, and reseed areas where vegetation is thin or absent. This is especially important for slopes, ditches, and channels.

Seed and mulch or cover exposed soil with erosion control matting within 48 hours of establishing final grade.

Removing temporary sediment controls

When project is completed:

- Remove all silt fencing and stakes. Grade out and seed or remove accumulated sediment or broadcast over grassed areas or dispose of off-site, where sediment will not impact waters of the State.
- Culvert inlets should be stabilized, vegetated, and showing no visible gullies. Rock or soil that has been washed away by runoff or upstream flows should be replaced. Brush or other debris that could clog inlets should be removed.
- Check ditches and channels to make sure banks and ditch bottoms are well vegetated. Reseed bare areas and replace rock that has become dislodged.
- Check areas where erosion control blankets or matting was installed. Cut away and remove all loose, exposed material, especially in areas where walking or mowing will occur. Reseed all bare soil areas.
- Replace rock washouts near culvert and channel outlets. Fill, grade, and seed or riprap eroded areas around inlets and outlets. Make sure downstream ditches and channels are fully vegetated. Fill and seed any gullies along the banks or other slopes.
- Fill in, grade, and seed all temporary sediment traps and basins that have been removed. Double the seeding rate where runoff flows might converge or high velocity flows are expected.
- Remove temporary stream crossings and grade, seed, or re-plant vegetation removed during crossing installation.

Acknowledgements

Design details and standards for erosion prevention and sediment control practices have been adapted from the New York State Standards and Specifications for Erosion and Sediment Control. August 2005.

This document is based on a similar Field Guide produced by the Tetra Tech Water Resources Division in Fairfax, VA for the Kentucky Division of Conservation and Division of Water. Inquiries regarding this publication should be directed to Barry Tonning, Tetra Tech, 1060 Eaton Place, Suite 340, Fairfax, VA 22030 (703.385.6000).

For additional copies
of this Field Guide, contact:

Vermont Department of Environmental Conservation
Watershed Management Division - Stormwater Section
One National Life Drive, Main Building - 2nd Floor
Montpelier, VT 05620-3522

Tel: 802-828-1535
Fax: 802-828-1544

dec.vermont.gov/watershed/stormwater