

Watershed Surfaces

CHARACTERISTICS WHICH AFFECT THE POTENTIAL FOR EROSION:

- ⊙ Topography: Larger drainages and steeper slopes result in more erosive potential.
- ⊙ Vegetation: Denser vegetation provides greater soil protection (to reduce impact of rain and to slow runoff).
- ⊙ Soil type: (permeability, depth, texture, and structure) Coarse and sandy soils are more permeable and more likely to erode than sticky clays.
- ⊙ Conditions adjacent to the site: Any given erosion event or process must be considered in the context of the system or watershed as a whole. Adjacent sites most immediately affect the dynamics that contribute to erosion.

THE NET EFFECT OF EROSION:

- ⊙ To remove soil particles, mineral nutrients, and organic matter that support vegetation
- ⊙ To leave coarser, less fertile soil behind

METHODS

The following techniques for addressing erosion across watershed surfaces (1) may be used in combination and (2) must be maintained to ensure proper functioning. Each is introduced in some detail on the following pages.

- | | |
|----------------------------|-------------------------------|
| ✓ berms | ✓ sandbag barriers |
| ✓ brush barriers | ✓ sediment basin or traps |
| ✓ check dams | ✓ sheet mulching |
| ✓ dewatering structures | ✓ silt fences |
| ✓ erosion-control blankets | ✓ sodding |
| ✓ fencing | ✓ straw-bale barriers |
| ✓ filter strips | ✓ surface roughening |
| ✓ outlet protection | ✓ swales (diversion channels) |
| ✓ revegetation | |

*Erosion:
The carrying away
of individual soil particles*

*Sheet Erosion:
The washing away
of soil particles
in thin layers*

*Rill Erosion:
The formation of small channels as
soil particles are washed away*

*Soil:
Unconsolidated material
that serves
as the rooting medium
or plants*

*Soil Texture:
Characterized by proportion,
by weight, of each size class
(clay, silt, sand)*



GENERAL DESIGN CONSIDERATIONS

Suspended and settling sediment can have detrimental effects upon:

- (1) water quality (e.g., turbidity, which decreases the amount of light available to plants in wetlands resulting in decreased productivity);*
- (2) vegetation;*
- (3) fisheries;*
- (4) biological processes (e.g., suspended fine sand and silt interfere with the ability of aquatic invertebrates such as insects to filter their food from organic particles suspended in the water); impacts to invertebrates affect the whole food chain; and*
- (5) visual appeal.*

- ✓ Consider the degree to which erosion is a natural process in the system.
- ✓ Techniques for avoiding erosion are much more effective than techniques for removing suspended sediments.
- ✓ Address causes of erosion as well as impacts.
- ✓ Consider altering use patterns; this may call for watershed-wide, interdisciplinary collaboration.
- ✓ Consider using vegetation, rather than physical structures, to lessen impacts.
- ✓ An erosion- and sediment-control plan is required for all activities which will result in:
 - disturbance of the earth or
 - introduction of sediments into wetlands.
- ✓ Include erosion control in all plans for maintenance or construction. Address on-site and adjacent areas of concern:
 - Minimize the area to be disturbed (including by soil compaction).
 - Minimize the duration of disturbance.
 - Stabilize disturbed areas immediately.
 - Use perimeter control (including retention) to minimize runoff. Route all runoff from a disturbed site through a sediment-entrapment structure on-site.
 - Minimize velocity of unavoidable runoff.



BERMS

DEFINITION:

- ※ A ridge made of compacted soil

APPROPRIATE FOR:

- ❖ directing water from a maximum of 10 acres contributing surface;
- ❖ slopes of 5-10%;
- ❖ use in conjunction with swales to divert water eroding a streambank;
- ❖ diverting water along top of fill to avert erosion;
- ❖ directing clean water away from a disturbed site;
- ❖ use on contour in conjunction with swales to slow the flow of water in order to increase infiltration into soil.

DESIGN/CONSTRUCTION:

- ✓ Build berms on, or nearly on, contour. If berm is intended to divert water, create an uninterrupted, nearly level, steady grade to outlet. Maximum acceptable velocity of flow is 2'/sec.
- ✓ If berm diverts water from disturbed area, use in combination with a sediment trap.
- ✓ Build berms at least 18" high and 4.5' across at the base. Allow for 10% settling.
- ✓ Use compact soil or coarse aggregate.
- ✓ If used in combination with a ditch/swale, swale is uphill.
- ✓ Stabilize soil surface immediately.

MAINTENANCE:

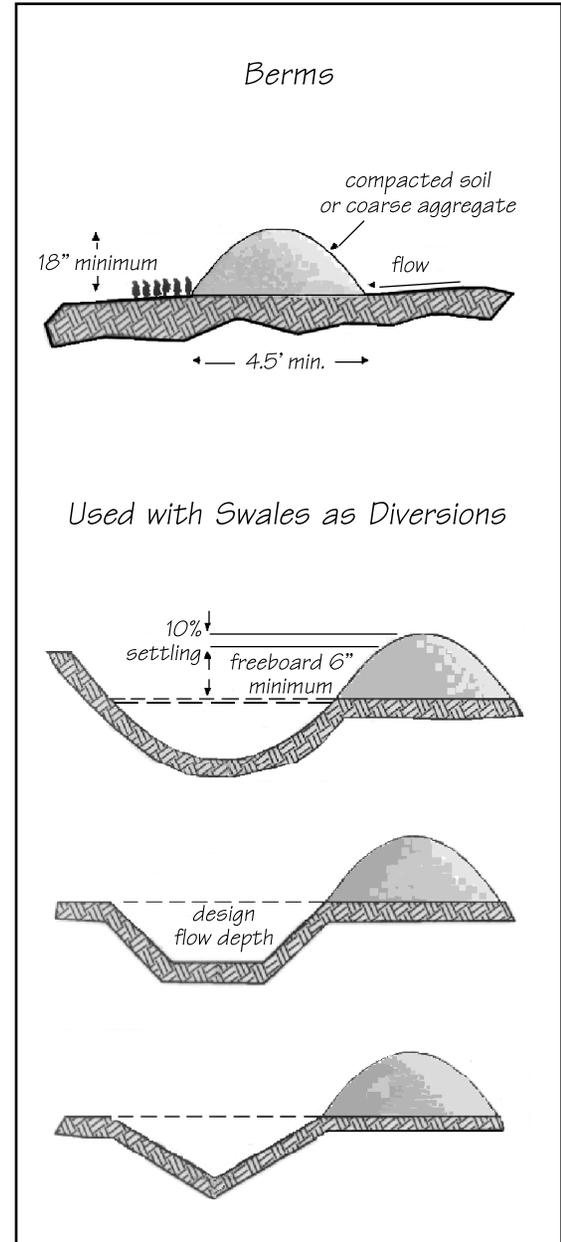
- ☒ Check routinely for structural soundness. Execute repairs immediately to prevent rapid erosion.

Earth Berm Design Criteria

	Example A	Example B
Drainage area	0-5 ac.	5-10 ac.
Berm height	18"	30"
Berm width*	24"	36"
Side slopes	2:1 max.	2:1 max.
Flow width**	48"	72"
Flow depth**	12"	24"

* Width at crest of berm
 ** For berms without swales: flow width and depth delineate impoundment area uphill from berm.

Height (in feet)	Top Width	Base Width (minimum)
1.5	2.0	8.0
2.0	2.0	10.0
2.5	2.5	12.5
3.0	2.5	14.5
3.5	3.0	17.0
4.0	3.0	19.0
4.5	4.0	22.0
5.0	4.5	24.5



(Illustration adapted from Colorado DOT 1995)

BRUSH BARRIERS

DEFINITION:

- ※ A temporary sediment barrier constructed from materials available from clearing and grubbing a site (*e.g.*, brush, limbs, root mats, weeds, rock) generally covered with filter fabric

APPROPRIATE FOR:

- ❖ intercepting sediment from a disturbed area.

DESIGN/CONSTRUCTION:

- ✓ Follow the contour.
- ✓ Pile brush, stone, root mats, and other material from clearing and grubbing process into a mounded row, at least 3' high and 5' wide at its base.
- ✓ Excavate a 4" x 4" trench along upslope margin.
- ✓ Lay filter fabric across mound from the trench to just past its peak. Splice strips together, and seal securely.
- ✓ Stake fabric in trench at 36" intervals.
- ✓ Backfill and compact the excavated soil.
- ✓ Set stakes and anchor fabric on downslope side, using twine from the fabric.

MAINTENANCE:

- Inspect for leaks; repair or replace promptly.
- Do NOT allow sediment to accumulate to more than 1/2 the height of the exposed barrier.
- Remove when barrier has served its purpose.

CHECK DAMS

DEFINITION:

- ✘ Small temporary dams constructed across a channel that carries water at some time (*e.g.*, diversion channels, gullies, streams)

APPROPRIATE FOR:

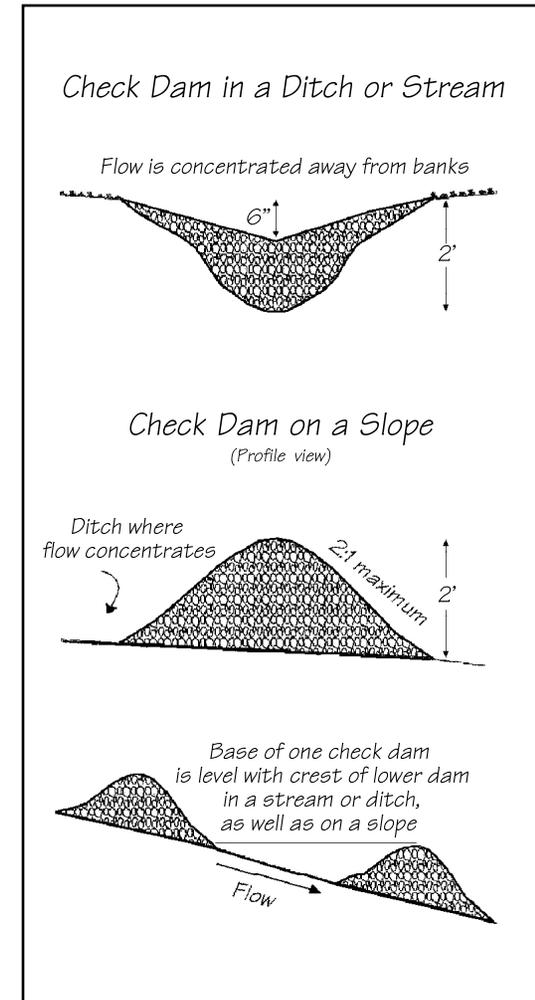
- ❖ use in channels that are no more than 4' deep;
- ❖ reducing the velocity of concentrated stormwater flows, ideally to non-erosive velocities (less than 2'/second);
- ❖ rebuilding incised channels;
- ❖ providing temporary protection while vegetation takes hold within channel; and
- ❖ sites which channel water from no more than 10 acres.

DESIGN/CONSTRUCTION:

- ✓ To minimize the potential for erosion of banks, select a site where the channel is straight.
- ✓ In selecting a site, consider the effects of impounded water on the upstream reach.
- ✓ The maximum height of the check dam is 2' (at the weir/low point), or 1/2 the depth of the associated channel.
- ✓ Key ends of dam into the adjoining berms, banks, and bottom of the channel.
- ✓ Construct a weir section at the center of the dam, at least 6" lower than the crest of the adjoining berms.
- ✓ For a stone dam, build the top 4-6" of the berms on either side with 4-8" stone; nearly fill the channel with the same.
- ✓ For log dams, use 4-6" logs salvaged from selected clearing on site, if possible. Key into bottom, bank, and adjoining berms at least 18". Line keyed sites with rock. Place logs carefully to ensure that weir section is 6" lower than ends, and/or notch center section once logs are in place.
- ✓ Line the upstream side of the dam with 3/4-1/2" crushed aggregate, 1' deep.
- ✓ Secure rock, logs, or brush on downstream side to prevent scouring during high flows.
- ✓ Maximum spacing of successive dams places the base of one dam level with crest of another, or closer, as necessary to ensure that the contributing drainage area is less than 10 acres.
- ✓ (See also "Check Dams" in *Streams & Banks* page 58)

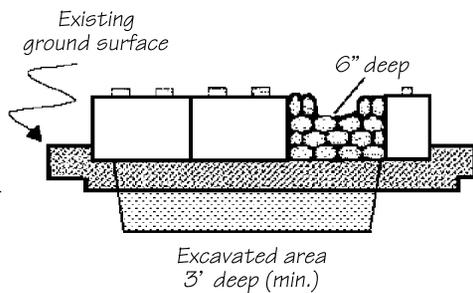
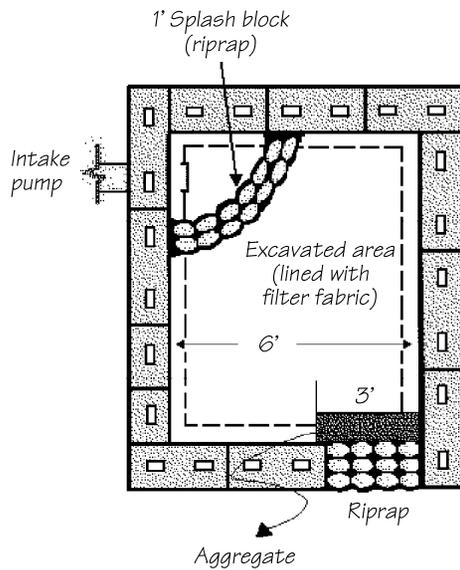
MAINTENANCE:

- ☒ Remove sediment, or adjust height of dam(s), when sediment has accumulated to 1/2 of berm height.
- ☒ Remove dam when it has served its purpose.



(Illustration adapted from Colorado DOT 1995)

Sediment Trap
or
"Dewatering Structure"



(Illustration adapted from Colorado DOT 1995)

DEWATERING STRUCTURES

DEFINITION:

- ✘ Structures intended to intercept wastewater and sediment that would otherwise erode and/or clog elements of the downstream drainageway and the receiving water.

APPROPRIATE FOR:

- ❖ collecting wastewater, reducing flow velocity, and reducing sediment loads;
- ❖ placement at the lower topographical positions at construction sites; and
- ❖ placement at sites where periodic erosion can occur.

DESIGN/CONSTRUCTION:

- ✓ Line the entire inside face of erosion bales/embankment with an impermeable geotextile (fabric used to prevent soil erosion; see "Sources of Materials and Additional Information" in *Attachments*).
- ✓ Line excavated basin with filter fabric.
- ✓ The outlet must be at least 3' wide and at least 6" below the top of erosion bales/embankment.
- ✓ (See also "Sediment Traps," page 10)

MAINTENANCE:

- Do NOT allow sediments to accumulate above half of excavated depth.

EROSION-CONTROL BLANKETS

DEFINITION:

- ✘ Material installed to protect erosive soils on slopes, in drainages, and in high-use areas

APPROPRIATE FOR:

- ❖ protecting and stabilizing slopes;
- ❖ covering erosive soils prior to the establishment of vegetation;
- ❖ protecting erosive soils in high-use areas; and
- ❖ protecting existing ground surfaces under temporary fills.

INSTALLATION:

- ✓ Prepare and seed the area.
- ✓ Unroll blankets in direction of water flow (90° to contour).
- ✓ Do NOT stretch.
- ✓ Bury upslope end in a 6" x 6" trench beyond crest of slope to avoid undercutting.
- ✓ Overlap ends at least 6" and sides at least 4". Uphill strip overlaps downhill strip.
- ✓ In channels, bury blanket in a 6" x 6" trench, at ends, and every 30'. Before backfilling, staple across width of trench in zigzag pattern at 6" intervals. Backfill to grade and tamp by foot.
- ✓ Use pins or staples made of 4.2 mm (0.162") wire, or heavier. "U" staples must have 8" legs and 1" crowns. "T" pins must be at least 8" long and 4" across the top. Triangular survey stakes may also be used. Follow manufacturer's recommendation regarding stapling pattern.

MAINTENANCE

- ☒ Monitor; re-anchor and replace as necessary.

FENCING

DEFINITION:

- ※ Barrier designed to enclose or exclose an area

APPROPRIATE FOR:

- ❖ enclosures of wildlife, livestock, and people;
- ❖ protecting trees, understory vegetation, and soils from construction activities

DESIGN/CONSTRUCTION:

- ✓ Consider snowpack and high-water levels.
- ✓ Consider wildlife movement patterns (*e.g.*, beaver, amphibians, deer, fish).
- ✓ Consider domestic livestock.
- ✓ Whenever possible, establish fencing outside of wetland, to minimize impacts and maintenance requirements.
- ✓ Temporary fencing can be used to demarcate wetlands and other areas for protection during construction projects.
- ✓ (See also “Fencing & Armoring” in *Plantings & Vegetation*, page 27 and “Fencing” in *Streams & Banks* page 61)

FILTER STRIPS

DEFINITION:

- ※ Undisturbed strips of land bordering surface waters. At least 20’ width of dense native vegetation. Serve to prevent soil erosion and filter sediments for brief periods of time (see “Revegetation,” following page).

MULCHING

(see “Sheet Mulching,” page 13 and “Mulching” in *Plantings & Vegetation*, page 31)

OUTLET PROTECTION

DEFINITION:

- ✘ Erosion-resistant surface provided at the outlet of a water course

APPROPRIATE FOR:

- ❖ diffusing energy and
- ❖ trapping sediments.

DESIGN/CONSTRUCTION:

- ✓ Place geotextile on original surface before placing outlet/apron and riprap. Do NOT puncture fabric. Overlap two pieces of fabric no less than 1'.
- ✓ Set outlet and apron so that grade is level (0%).
- ✓ Line the apron of the outlet with riprap, grouted riprap, concrete, or gabion baskets.
- ✓ If high flow volume is anticipated, create a well defined channel by filling with stone up and around the sides of the outlet/apron.

MAINTENANCE:

- ☒ Inspect for scour after high flows. Repair immediately.

(RE)VEGETATION

(See *Plantings & Vegetation*, pages 23-55)

GENERAL DESIGN CONSIDERATIONS:

- ✓ Use natives species and local stock.
- ✓ See species and habitat listings for establishing habitat diversity
- ✓ Consider multiple functions of each species and community structure:
 - life expectancy
 - aesthetic values
 - habitat (including diversity, patchiness)
 - structure/shade/natural succession
 - maintenance needs/cleanliness/weediness

SANDBAG BARRIER

DEFINITION:

- ✘ Temporary structures to guide runoff

APPROPRIATE FOR:

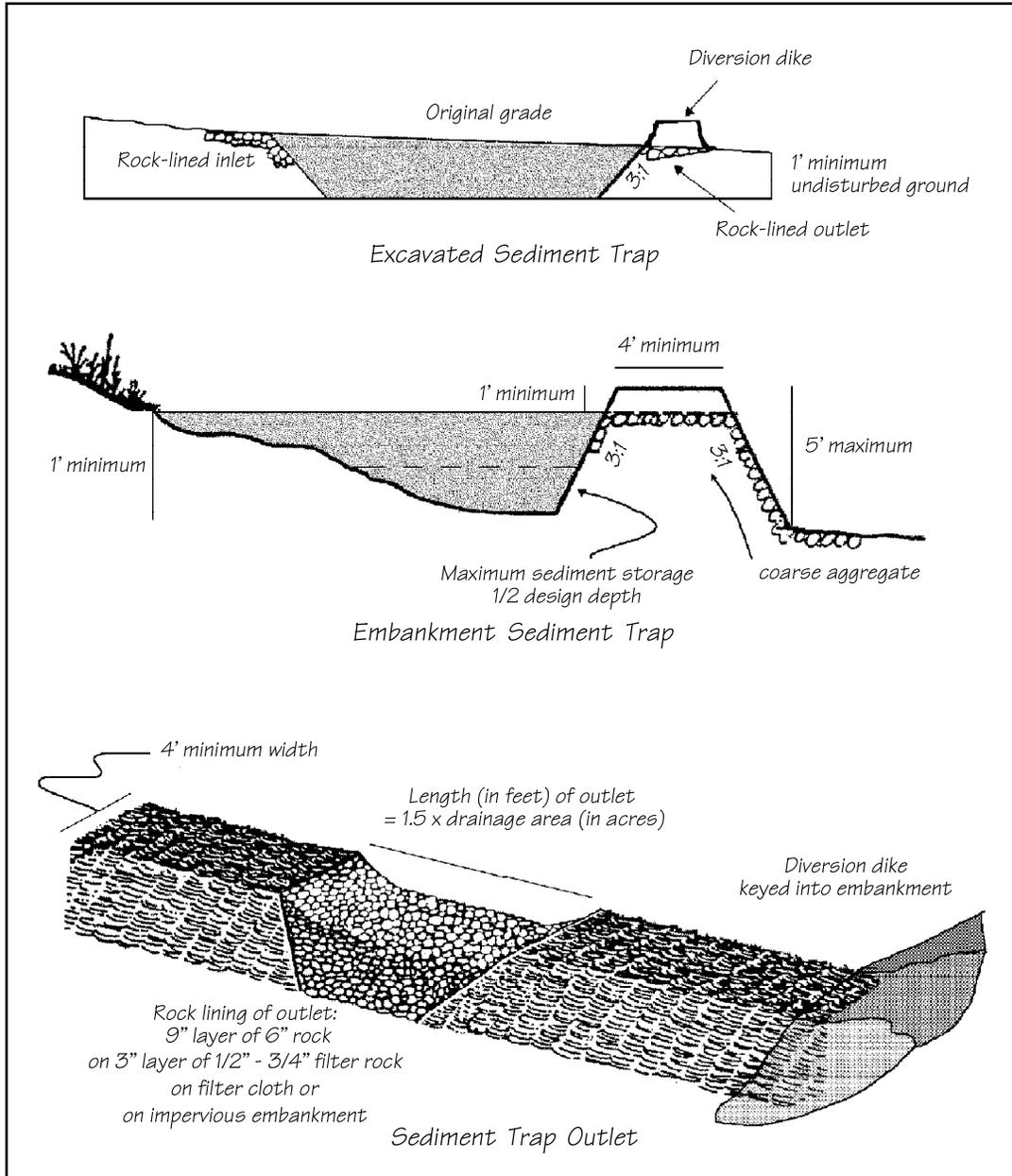
- ❖ directing water from a maximum of 10 acres contributing surface;
- ❖ slopes of 5-10%;
- ❖ use in conjunction with swales to divert water eroding a streambank;
- ❖ diverting water along top of fill to avert erosion;
- ❖ directing clean water away from a disturbed site;
- ❖ use on contour in conjunction with swales to slow the flow of water in order to increase infiltration into soil.

DESIGN/CONSTRUCTION:

- ✓ Height: 18"
- ✓ Base width: at least 48"
- ✓ Stack sandbags using an alternately layered method.
- ✓ When waterproofing is desired, cover with a plastic liner. Bury upslope/upstream end.

MAINTENANCE:

- ☒ Inspect routinely; repair any breaks promptly.
- ☒ Do not allow sediment to accumulate more than 6".



(Illustration adapted from Virginia Division of Soil and Water Conservation 1992)

SEDIMENT TRAP (TEMPORARY)

DEFINITION:

- ✧ A small temporary ponding/settling area, formed by an earthen embankment across a drainageway or by excavation of a depression below original grade. The ponding area is equipped with a stone outlet or a controlled stormwater release structure.

APPROPRIATE FOR:

- ❖ detaining on-site runoff long enough to allow sediment to settle out;
- ❖ points of discharge from disturbed areas where the contributing drainage area is less than 3 acres;
- ❖ up to 18 months;
- ❖ use in combination with a temporary diversion dike, or independently.

NOTES:

- ⊙ Do NOT construct a sediment trap in a flowing channel.
- ⊙ For a smaller model, see "Dewatering Structures," page 6.
- ⊙ To accommodate a larger drainage area, construct a series of sediment traps.

DESIGN/CONSTRUCTION:

- ✓ Construct trap before upslope disturbance begins.
- ✓ Include plans for removal and restoration of original grades.
- ✓ Position trap no closer than 20' from a proposed or existing building or roadway.
- ✓ Calculate a storage area of 134 cubic yards/acre of drainage area—half for a permanent pool, or “wet storage,” and half for drawdown, or “dry storage”, which will provide extended settling time during storm events.
- ✓ The permanent pond/wet storage/sediment basin must be at least twice as long as it is wide. If landforms do not allow this configuration, install baffles half way between in- and outflow points.
- ✓ Excavate the permanent pond. To facilitate cleaning and for safety considerations, depth of the permanent pool must be no more than 4'. Excavated slopes shall be no steeper than 30% grade (2:1).
- ✓ Impound the dry storage behind an earth embankment built up no more than 5' above ground level (as measured on the downstream side).
- ✓ The upslope surface of the berm must grade, laterally as well as vertically, toward the outflow.
- ✓ Build a segment of the embankment out of riprap and aggregate to serve as an outflow and filter. This stone outflow segment must be at least 6' long for every acre of drainage area served. To ensure that overflow escapes only over the stone surface, the top or crest of this stone segment must be at least 1' lower than the top of the earth embankment.
- ✓ Design the ponded area so that the surface dimensions when filled to the top of the stone outlet (maximum dry storage) is at least twice as long as wide.
- ✓ The depth of wet storage (D_{wet}) is the depth of the excavated area. Calculate the surface area flooded when water stands at the base of the outlet (A_{base}). The wet storage volume is approximately 85% of this surface area times the depth ($D_{wet} \times A_{base} \times 0.85 = V_{wet}$)
- ✓ The depth of dry storage (D_{dry}) is the height of the stone outlet. Calculate the area flooded when the water stands at (1) the base and (2) the crest of the outlet. Calculate the difference (subtract 1 from 2). Dry storage volume is approximately this difference ($A_{crest} - A_{base}$) times the height of the outlet.
- ✓ Maximum height of the embankment is 5'; maximum depth of the excavation is 4'.
- ✓ Crest of the outlet must be at least 1' lower than the top of the embankment.
- ✓ Side slopes of embankments must be no steeper than 30% grade (2:1).
- ✓ Minimum embankment top width and base width are shown in the box on this page.

*Design Dimensions
for Sediment Trap Embankments*

(in feet)

<i>Height*</i>	<i>Freeboard</i>	<i>Top Width</i>
1.5	1.0	2.0
2.0	1.0	2.0
2.5	1.0	2.5
3.0	1.0	2.5
3.5	1.0	3.0
4.0	1.0	3.0
4.5	1.0	4.0
5.0	1.0	4.5

* From original ground surface

(continued)

TEMPORARY SEDIMENT TRAP (CONTINUED)

- ✓ Clear the area under the embankment of all vegetation and roots.
- ✓ Ensure that fill for the embankment is free of organic matter and large stones.
- ✓ The stone for the outflow shall be a combination of "Class 1" riprap (4-8" rock) for stability and coarse aggregate (1/2-3/4" rock; smaller aggregate improves filter effectiveness).
- ✓ Line the interface between stone and the earth embankment with a separator of filter cloth. Filter cloth should extend (1) far enough for the ends to be keyed into a trench or buried beneath riprap, (2) beyond crest height, and (3) to the edge of the outflow.
- ✓ Compact fill on the embankment in 6" layers by traversing with construction equipment.
- ✓ Pave the surface of the overflow with riprap.
- ✓ Seed the embankment immediately.
- ✓ Install permanent marker indicating maximum allowable sediment buildup.

NOTE:

- ⊙ Cubic feet x 0.037 = cubic yards

MAINTENANCE:

- ☒ Remove sediment and restore trap configuration when wet storage volume has been reduced to 1/2.
- ☒ Deposit sediment in a way that ensures it will not cause further sedimentation problems.
- ☒ Check filter stone regularly to ensure performance is maintained. Clean or replace stone that becomes choked with sediment.
- ☒ Check the trap regularly for structural integrity. Watch for damage by erosion or construction equipment.
- ☒ Confirm that stone outlet is at least one foot below the top of the embankment.
- ☒ When the upslope area is stabilized, remove the trap, restore the original grades, and stabilize surfaces.

SHEET MULCHING

DEFINITION:

- ✧ The installation of a protective covering (blanket) or soil-stabilization mat. Plant fibers typically used for mulch include straw, hay, and wood cellulose fiber.

APPROPRIATE FOR:

- ❖ preventing erosion by protecting the soil surface from raindrop impact and reducing the velocity of overland flow;
- ❖ fostering the growth of vegetation by increasing available moisture and providing insulation against wind and extreme heat and cold;
- ❖ short, steep slopes where erosion hazard is high and planting is otherwise likely to be too slow in providing adequate protective cover;
- ❖ stream banks and shorelines where moving water is likely to wash out new plantings; and
- ❖ areas where wind is likely to prevent other standard mulching practices from remaining in place until vegetation becomes established.

DESIGN/IMPLEMENTATION:

- ✓ Use weed-free, seed-free, preferably organic, long-stemmed grass (NOT cereal-grain which may have secondary compounds toxic to other species) straw (stalks).
- ✓ At least 50% of the material (by weight) should be at least 10" long.
- ✓ Apply immediately after seeding.
- ✓ Apply straw evenly at a rate of 2 tons/acre (1-2" deep).
- ✓ Flake bales so that fibers remain interlocked, wind-resistant, and erosion-resistant; do NOT shred bales. Do NOT leave more than 10% of the soil surface exposed.
- ✓ Apply wood cellulose fiber at a rate of 1500 pounds/acre with a hydraulic seeder or mulcher. Mix the mulch with water (1 pound of fiber:2 gallons water) and tackifier.
- ✓ Where slopes are greater than 30%, use blankets or nets anchored to the soil. Where slopes are less than 30%, crimping is recommended.
- ✓ Tackifiers if used to anchor mulch (acceptable in small areas sheltered from wind and heavy runoff), must NOT contain substances which might inhibit germination and plant growth (*e.g.*, mineral filler, recycled cellulose fiber, clays). Powder derived from Desert Indianwheat (*Plantago insularis*) may be used. Apply in a slurry (100 pounds powder/150 pounds wood fiber/700 gallons water). Apply powder at a rate of 80-200 pounds/acre.

MAINTENANCE:

- Inspect frequently and reapply where necessary.

SILT FENCES

DEFINITION:

- ※ A temporary sediment barrier consisting of a synthetic filter fabric supported by wooden or steel posts and entrenched

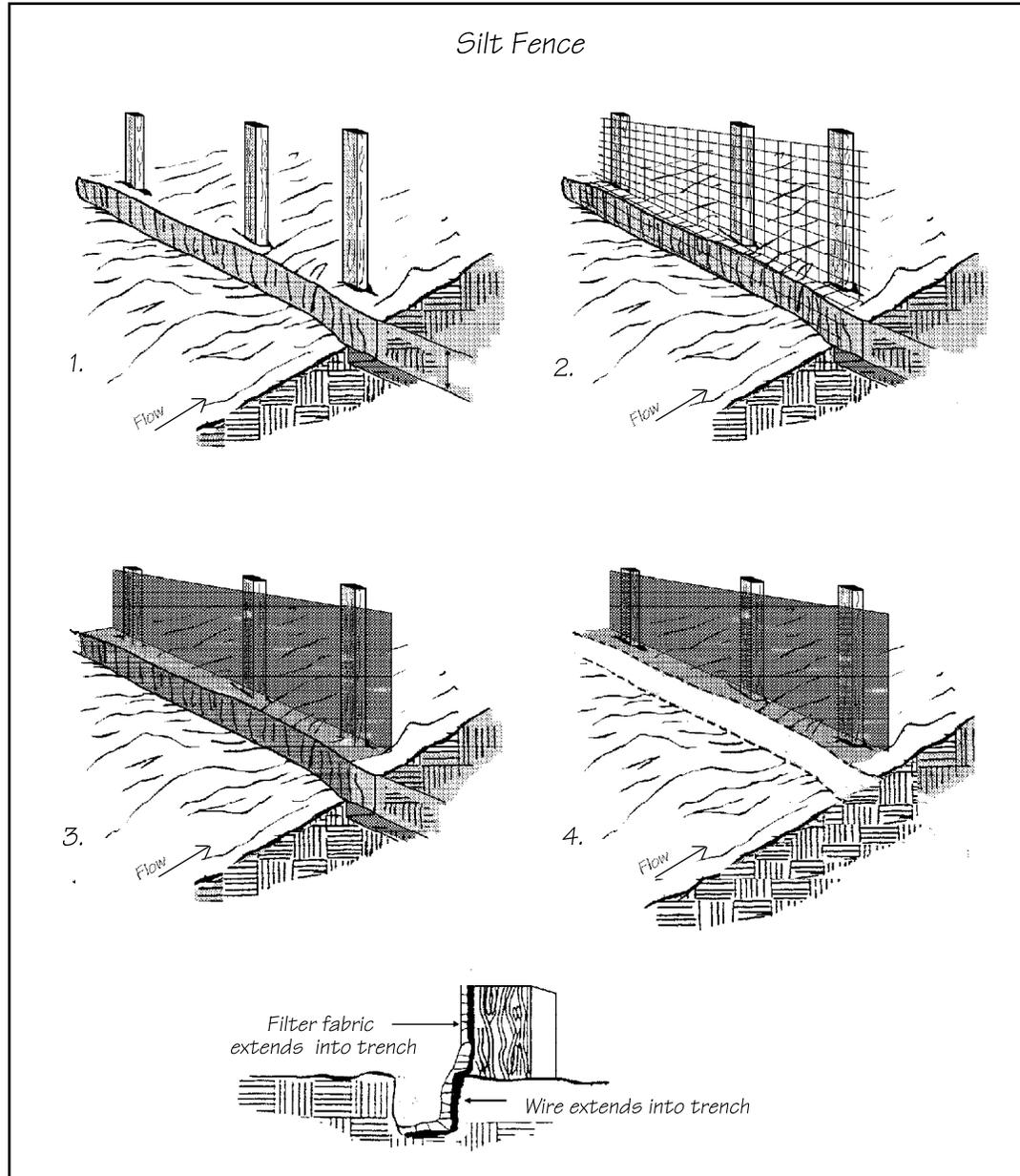
APPROPRIATE FOR:

- ❖ areas subject to sheet and rill erosion (*e.g.*, the toe of fills, at transitions between cuts and fills, adjacent to streams);
- ❖ intercepting and detaining small amounts of sediment;
- ❖ decreasing the velocity of sheet flows and concentrated level flows of low-to-moderate volumes;
- ❖ areas where maximum slope above the barrier is 100';
- ❖ areas where maximum grade is 50%;
- ❖ areas where maximum drainage size is .25-.50 acres/100' of fence;
- ❖ situations which call for more durability than straw-bale barriers;
- ❖ situations in which effectiveness is required for less than three months;
- ❖ use in minor swales, channels, and ditch lines where the maximum contributing drainage is 1 acre and maximum flow is 1 cfs (approximately 0.3 gallons/sq.ft./minute); and
- ❖ situations in which filter efficiency of 95-100% is desired.

NOTES:

- ⊙ NOT appropriate for use in channels where flow is likely to exceed 1 cfs.
- ⊙ NOT appropriate where substrate prevents entrenching of filter fabric.
- ⊙ Silt fences pass water more slowly, create more ponding, and trap sediment much more effectively than straw bale barriers.
- ⊙ While all fabrics are effective sand filters, each varies in effectiveness for filtering clay and silt. Permeability rates vary.

Silt Fence

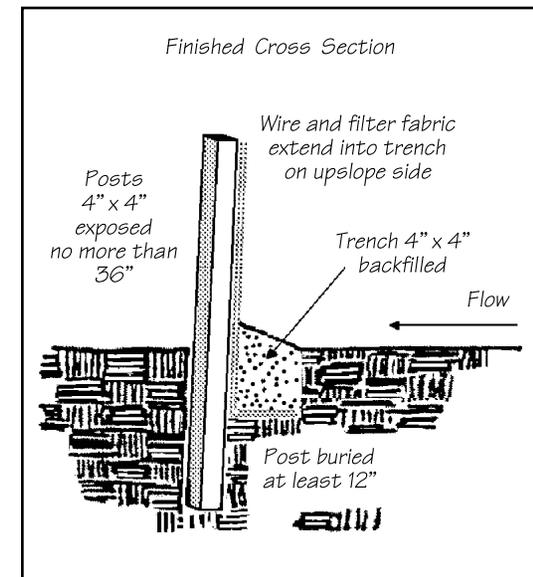


(Illustration adapted from Sherwood and Wyant)

DESIGN/CONSTRUCTION:

- ✓ Install fence on contour.
- ✓ Ensure that the area below the fence is undisturbed or stabilized.
- ✓ Position barrier at least 5' from base of slope greater than 7% to allow for runoff to pond and infiltrate, sediment to settle.
- ✓ Fencing across a swale or ditch must arc with ends upstream and must be long enough to prevent endflow. To achieve this, the base of the fence at the upstream ends must be higher than the elevation of the top of the lowest portion of the fence. Use extra-strength fabric. Place posts no more than 3' apart.

(continued)



(Illustration adapted from Virginia Soil and Water Conservation Division 1985)

SILT FENCES (CONTINUED)

- ✓ Fence fabric must stand 24-36" above existing grade (allow for 10" buried). Higher structures will not be stable under pressure of the water they impound.
- ✓ If fence is used in swale (with no more than 1 acre of contributing drainage), maximum height is 15".
- ✓ Select filter fabric in continuous rolls to minimize the need for joints.
- ✓ Select fabric that is impregnated with UV inhibitors to provide a minimum life of 6 months at temperatures from 0-120°. If burlap is used, select fabric that is 10 ounces/square yard.
- ✓ Posts must be 5' in length, driven vertically at least 18" into the ground, at 6' intervals on contour.
- ✓ For use in swales, space posts 3' apart.
- ✓ Wooden posts, if used, must be 2" x 2" if oak; 4" x 4" if pine.
- ✓ Standard "T" or "U" steel posts, if used, must be at least 1.33 pounds/linear foot. Protect these against corrosion. Select metal posts with protrusions for securing wire.
- ✓ Excavate trench (6" x 6") on upslope side.
- ✓ Wire fence reinforcement for silt fences using standard filter cloth must be 36" wide/high (including 2" buried), with mesh spacing no larger than 6" (14 gauge).
- ✓ When wire is used, posts must be no more than 10' apart. Fasten fence securely to upslope side of posts using heavy-duty wire staples at least 1" long (#9), tie wires, or hog rings. Do NOT staple fabric to existing trees.
- ✓ When wire is not used, use extra-strength fabric. Place posts no more than 6' apart. Staple or wire fabric to upslope side of posts, extending 10" into trench.
- ✓ In all cases, avoid seams in fabric. If necessary, overlap at least 6" at posts and seal securely.

MAINTENANCE:

- Silt fences shall be inspected immediately after each rainfall and at least daily during prolonged rainfall.
- Repair damage, end runs and undercutting immediately.
- Remove sediment deposits after each storm event; deposits must not accumulate higher than 1/2 the height of the exposed barrier.
- Remove barrier when upslope area is permanently stabilized. Restore any remaining deposits to conform with existing grade, and seed the site.

SODDING

DEFINITION:

- ✧ Strips of prepared grass cover

APPROPRIATE FOR:

- ❖ sites where immediate ground cover and/or filter strips are desired;
- ❖ sites where seed would be subject to erosion, or consumption by rodents or birds;
- ❖ projects of very limited scope;
- ❖ areas where maximum length of slope above the barrier is 50'; and
- ❖ areas where maximum slope is 15% (6:1)

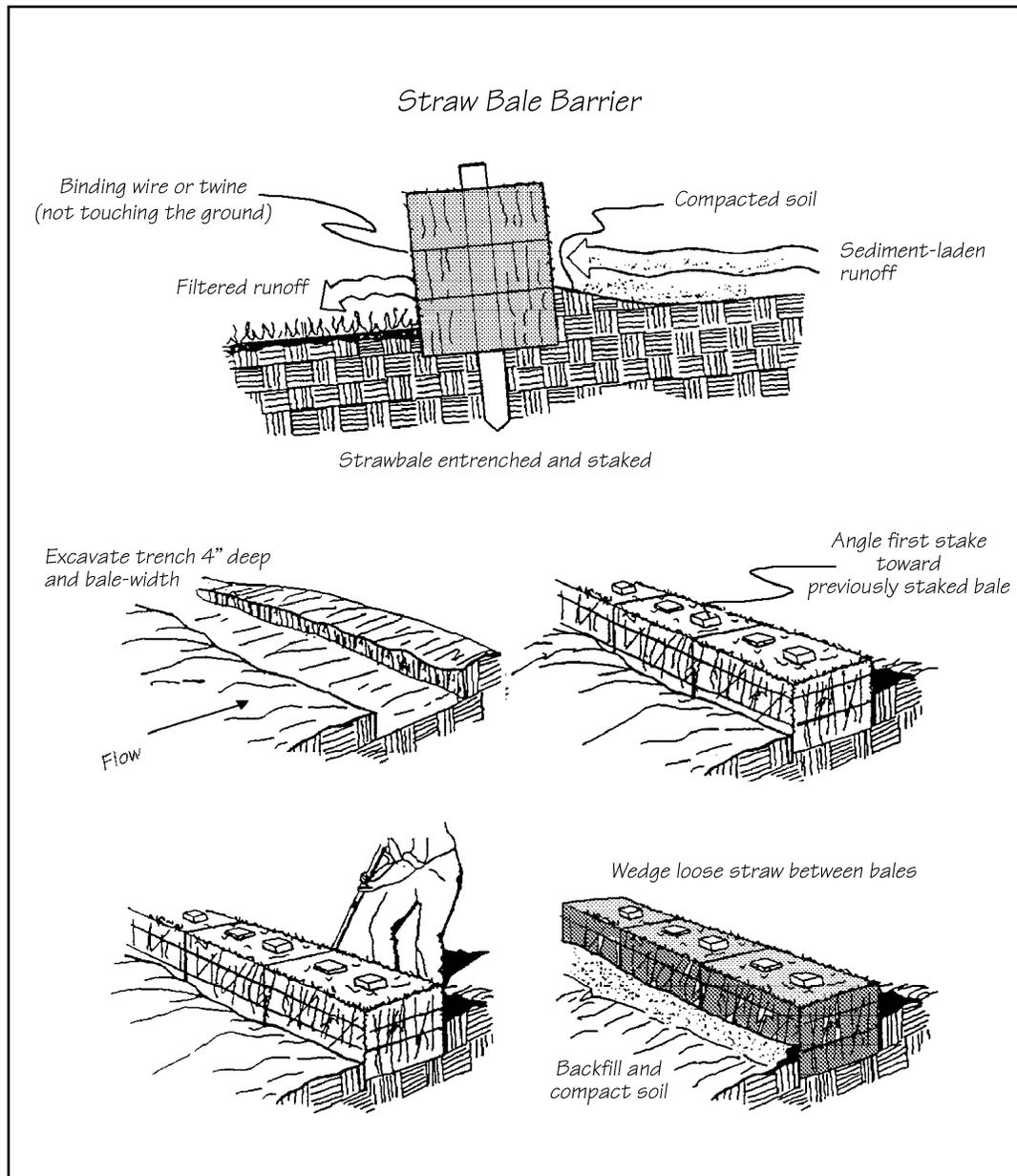
DESIGN/CONSTRUCTION:

- ✓ Use nursery-grown, weed-free sod, with soil thickness of 3/4-1" (to avoid over-drying where irrigation is not available or is faulty), at least 18" wide, and 48" long.
- ✓ Complete transplanting operations within 24 hours. This includes irrigation of laid sod within 8 hours.
- ✓ Grade to smooth surface, fertilize (only if necessary), and lightly irrigate soil bed before laying sod.
- ✓ Lay sod strips on contour. Wedge tightly together. Stagger joints.
For use as filter strips, sod strips must be of undisturbed, dense, native vegetation at least 20' in width. Blue grama/buffalograss, fescue, and bluegrass sods are available.
- ✓ Secure sod (by rolling, tamping, and pegging, or by other approved methods).
- ✓ Roll or tamp, water entire section. In the absence of rainfall, water daily throughout first week; maintain soil moisture to a depth of 4".
- ✓ (See also "Sodding" in *Plantings & Vegetation*, page 43)

MAINTENANCE:

- Mow only after sod is firmly rooted.
- Maintain grass height at 2-3".

STRAW-BALE BARRIERS



(Illustration adapted from Virginia Division of Soil and Water Conservation 1992)

DEFINITION:

- ✧ A temporary barrier consisting of a row of meticulously entrenched and anchored straw bales

APPROPRIATE FOR:

- ❖ areas subject to sheet and rill erosion (*e.g.*, the toe of fills);
- ❖ intercepting and detaining small amounts of sediment from disturbed areas of limited extent (bales may filter 60-70% of sediment load);
- ❖ decreasing the velocity of sheet flows;
- ❖ situations in which effectiveness is required for less than three months;
- ❖ sites where maximum area is 0.5 acres/100' of barrier;
- ❖ sites where maximum slope above the barrier is 15°;
- ❖ sites where maximum grade is 45%;
- ❖ sites where snowmelt and precipitation are not anticipated to create significant runoff; and
- ❖ situations in which a flow rate of 5-6 gallons/sq.ft./minute is acceptable.

NOTE:

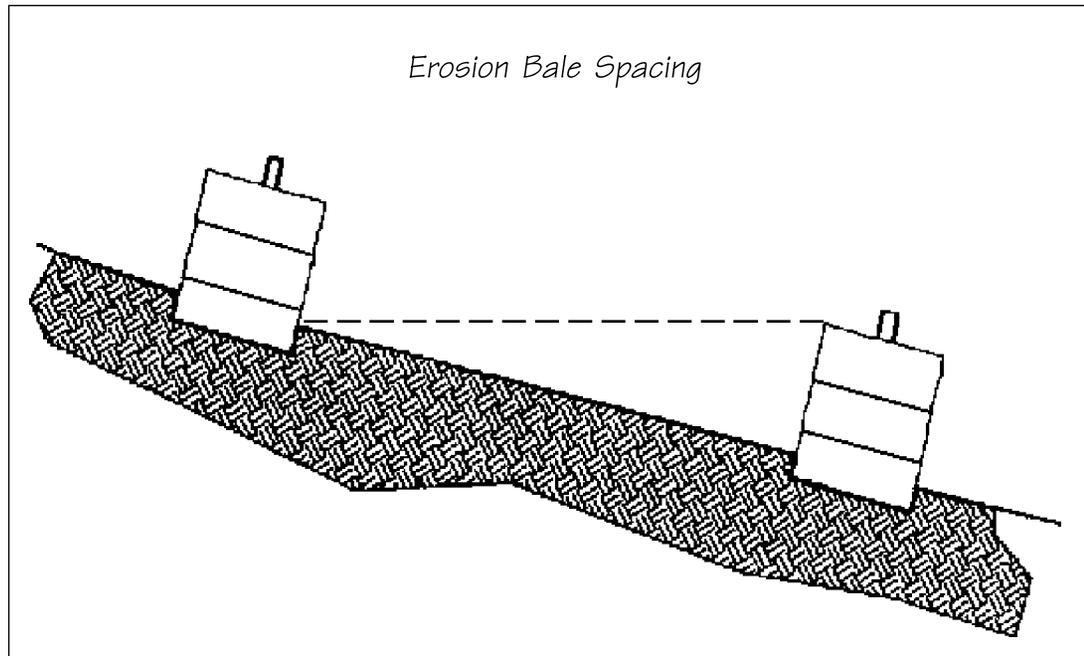
- ⊙ NOT suitable for high-flow situations (*i.e.*, swales, channels, or other sites of concentrated flow where contributing area is greater than 1 acre).
- ⊙ NOT suitable for use on hard surfaces which prevent full and uniform anchoring of the barrier.

DESIGN/CONSTRUCTION:

- ✓ Position barrier at least 5' from base of slope greater than 7% to allow runoff to pond and infiltrate and sediment to settle. In this way, initial movement of soil will not impede further effectiveness.
- ✓ Place bales on contour, in a single row, lengthwise, with ends tightly abutting one another.
- ✓ Place bales so that wire or twine bindings run around the sides rather than across top and bottom, to prevent deterioration of bindings.
- ✓ Entrench bales at least 4".
- ✓ To obtain tight joints, pin bales in position with two stakes (at least 2" x 2" x 36") or standard "T" or "U" steel posts (minimum weight 1.33 pounds/linear foot) driven toward the previously staked bale. Do NOT use rebar, as it has proven to be dangerous when protruding. Drive stakes at least 12-18" into the ground.
- ✓ Chink bales (fill gaps with loose straw) to prevent water from escaping between bales.
- ✓ Backfill bales with the excavated soil. Fill to ground level on downhill side; build up 4" on uphill side.
- ✓ Sheet mulch (flakes of straw bales) uphill from the barrier to increase efficiency.

MAINTENANCE:

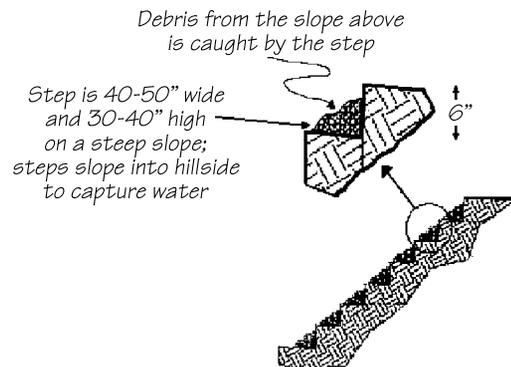
- ☒ Inspect bale barriers immediately after each rainfall and at least daily during prolonged rainfall.
- ☒ Repair damaged bales, end runs, and undercutting immediately.
- ☒ Remove sediment deposits when they reach 1/2 the height of the exposed barrier.
- ☒ Replace bales that are clogged with sediment. (Flake and spread as mulch over disturbed surfaces uphill from barrier.)
- ☒ Remove barrier when upslope area is permanently stabilized. Restore any remaining trenches and deposits to conform with existing grade, and seed them.



(Illustration adapted from Colorado DOT 1995)

Surface Roughening Methods

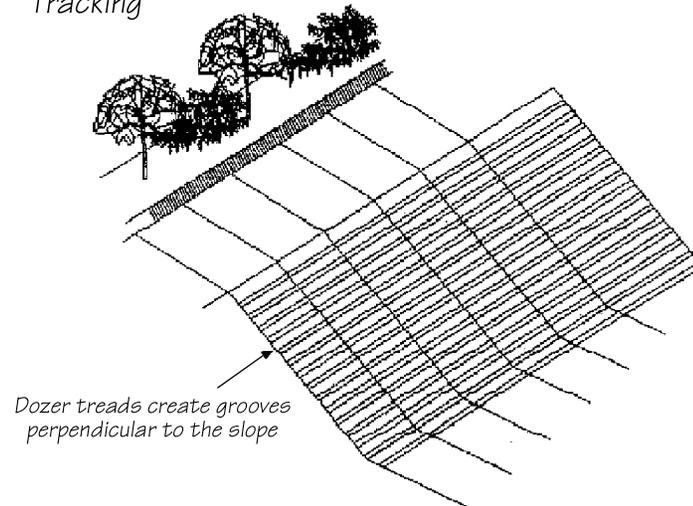
Stair-step Grading



Grooving

Furrows 3" deep are cut along the contour of a gentle slope. Crests are 12-15" apart.

Tracking



(Illustration adapted from Colorado DOT 1995)

SURFACE ROUGHENING

DEFINITION

- ✧ Creating topographic irregularities on any soil surface

APPROPRIATE FOR:

- ❖ surfaces of any slope, including level surfaces;
- ❖ reducing wind erosion and providing for sediment trapping (for up to one month);
- ❖ creating depressions to trap wind-blown seed and soil particles; thereby aiding in seed-bed preparation and establishment of vegetative cover; and
- ❖ reducing runoff velocity and increasing infiltration.

DESIGN/ CONSTRUCTION:

- ✓ The steeper a slope, the larger depressions or pits must be in order to withstand the erosive force of runoff.
- ✓ Series of pits may be created by inserting a shovel and leveraging the handle to open a space in the ground. Do not invert or otherwise loosen soils in this process.
- ✓ Orient ridges and depressions along the contour.
- ✓ Minimize compaction by heavy equipment.
- ✓ Seed and mulch surface as soon as possible.
- ✓ Do NOT drive on or otherwise compact areas that have been roughened.

SWALES

DEFINITION:

- ※ A ditch constructed on contour

APPROPRIATE FOR:

- ❖ decreasing effective length of a slope by intercepting runoff;
- ❖ a site where the tributary area is less than 10 acres but greater than that allowed for straw-bale barriers or silt fences (0.5 acres/100' of bales/fence);
- ❖ collecting water that would otherwise run off site;
- ❖ impounding water in order to increase infiltration and/or allow sediments to settle;
- ❖ use as a diversion channel (slightly off contour) to collect and route runoff through temporary sediment traps;
- ❖ use in combination with berms (see illustration in *Berms*, page 3).

DESIGN/ CONSTRUCTION:

- ✓ Dig swale up to 4' wide and at least 1' deep. Allow at least 4" freeboard. Maximum slope of sides is 30% (2:1).
- ✓ Remove obstructions to flow (*e.g.*, stumps, roots, rocks).
- ✓ Pile excavated soil on downhill side and compact. Anticipate that soil will settle 10%.
- ✓ Seed the channel, berm, and any disturbed area upslope immediately. Consider mulching seeded areas.
- ✓ (See also *Berms*, page 3)

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