Postfire Management: Erosion Control

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Erosion control is probably one of the most common rehabilitation activities after a burn, with success often measured in the quality of the stream at the bottom of the hill. In some regions, over 60 percent of total sediment production over the long-term is fire-related. Much of that sediment loss occurs in the first year after a wildfire, though in some cases, sediment accumulations and incision may take decades or even longer to recover to prefire conditions. Erosion control should only be used if you are trying to protect downstream values at risk and rehabilitation treatments that have an impact the first year will be important in minimizing damage to both soil and watershed resources.

Hill slope treatments

Hill slope treatments are intended to reduce surface runoff and keep soil in place. These treatments are regarded as the first line of defense against postfire erosion and unwanted sediment deposition. Common hill slope treatments are mulching, barriers such as contour-felled logs, straw wattles, silt fences, sandbags, and grass seeding.

Mulch

Mulch is used to cover the soil, thereby reducing rain impact, overland flow, soil erosion, and the effects of water repellent soils while increasing soil water content. Research has shown that mulching is the only treatment that consistently and significantly reduced erosion rates by immediately increasing the percent ground cover, compared to gradually increasing cover from growing vegetation.

There are many types of mulching materials to choose from. It is very important to use certified weed free products or materials. Mulch is often used in conjunction with grass seeding to provide ground cover in critical areas.

Straw is the most commonly used mulch. The effectiveness of using straw mulch will depend on how evenly and consistently it is applied. This treatment is most effective on gentle slopes and in areas where high winds are not likely to occur. Mulch is best used in high-value areas, such as above or below roads, above streams, or below ridge tops. Rated as the most cost effective type of mulch, straw is superior in protection to hydraulic mulches and comparable to expensive fabrics. Straw should be clean barley or wheat straw - using uncertified straw can introduce invasive plant species.

Straw mulch is labor intensive to apply correctly and can be difficult to maintain. On gentle slopes, hand broadcasting to a uniform depth of two to three inches is the best method of application. On steep slopes, the straw can be blown onto slopes at the same depths. The Forest Service uses one ton of straw per acre, which provides about 70 percent ground cover.

Straw mulch applied to a burned site.
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Mulch should be applied to the entire seeded or bare area and extend into existing vegetation. If the treatment area is prone to high winds, it may be necessary to punch the mulch into the soil with a spade, roller, or crimper. Mulch should be stabilized on all sides to prevent damage that starts at the edges. Hand punching mulch involves using a spade or shovel to punch straw into the slope until all areas have straw standing perpendicularly to the slope and embedded at least four inches deep every 12-inches apart. You can achieve the same effect by using a roller puncher equipped with straight studs that is rolled over the slope. Crimpers have serrated blades four to eight inches apart that force the straw mulch into the soil. Crimping should be done in two directions with a final pass across the slope.

Slash spreading is a common practice after timber sales, but can also be used on burned slopes where dead vegetation is present, and on firebreaks and dozer lines. This treatment is most effective on gentle slopes. Slash spreading provides many of the same benefits of straw, with the additional benefit of keeping and recycling nutrients back into the site. Sufficient material is usually available on-site in low- to moderately-burned areas, especially after salvage logging operations. Intensely burned areas may not have sufficient on-site material.

Application can be labor intensive. Using material that is smaller than three inches in diameter can mitigate concerns that slash will attract or harbor insects and/or add to fuel loads. Consult your state's Forest Practices Act for allowable amounts of residual slash. Slash will need to be cut small enough so that it has good contact with the soil. Avoid mechanically treating and spreading slash on wet soil as this will contribute to soil compaction.

Fabric mulches. Geotextile fabric mulches are used to cover the ground and control erosion in high risk areas such as extremely steep slopes, above roads or structures, or along stream banks. Geotextiles come in different grades with ultraviolet inhibitors that determine how long they will last in the field.

Barriers.

Barriers are installed on hill slopes along the contour to slow water flow, increase infiltration, and trap sediment.

Log barriers. Felling, placing and anchoring logs on the contour of a burn slope provides immediate protection and contour-felled logs are often used in the first year after a burn where erosion rates are expected to be high. This treatment is appropriate for slopes of less than 40 percent (see *Figure 12. Installing contour felled logs*).

Failures are common where water flows under logs. Placement along the contour is important. Studies have shown that misplacement of logs at more than two to five degrees off contour causes trap efficiency to decrease by 20% percent. Log barriers should be viewed as a short-term fix, with some structures filling in with sediment the first storm event after a burn, while others may take one to two years to fill.

In order to be economically feasible, you must have an adequate numbers of 15 to 20 feet long logs that are four to 12 inches in diameter available on the site. Install felled logs on the contour with good ground contact and proper anchoring. Establish good ground contact by delimbing beneath each log while leaving other branches intact and positioned downhill. Trenching to seat contour-felled logs will provide additional stability. Use wooden or re-bar stakes to anchor logs. Steep, shallow, and/ or rocky soils and uneven ground surfaces make anchoring difficult, so take extra care to ensure that logs are adequately secured. Berms made of piled up soil at the ends of logs will increase storage capacity by about ten to fifteen percent and are recommended.

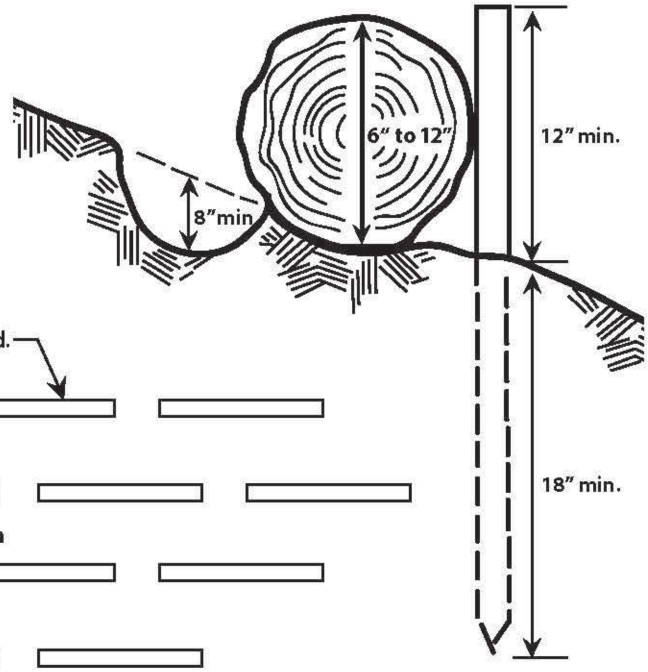
Straw wattles. In areas where you do not have a sufficient number of logs available, straw wattles may provide an alternative to contour-felled logs for breaking up slope length. The last two to three feet of the straw wattle should be turned upslope to prevent water and sediment from going around the structure and will increase storage capacity. Straw wattles can also be used in small drainages and on side slopes for catching sediment. The cost of installing straw wattles is about half that of contour-felled logs.

Sandbags. You can construct an inexpensive temporary barrier by stacking sand-or earth-filled sandbags one to two feet high. Sandbags can be positioned to divert mud and small debris flows away from buildings and roads, but they will not seal out water. They should be viewed as a short-term fix as they deteriorate when exposed to continued wetting and drying for several months.

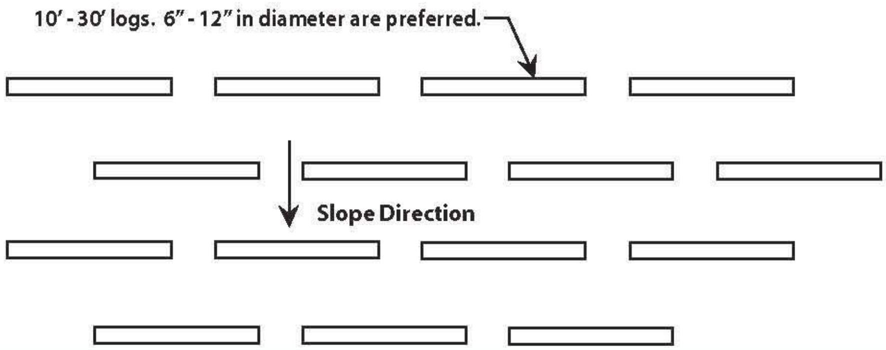
Figure 12. Installing contour-felled logs.

Recommended Horizontal Spacing

Slope Gradient	Low Fire Intensity	Medium Fire Intensity	High Fire Intensity
<5%	250 feet	160 feet	130 feet
5-10%	200 feet	120 feet	90 feet
10-20%	120 feet	60 feet	40 feet
20-50%	60 feet	30 feet	20 feet
>50%	40 feet	20 feet	20 feet



With contour log felling, trees are placed directly on the ground and staked in or wedged behind stumps.



Silt fences. Silt fences are made of woven wire and fabric filter cloth and are used as a temporary barrier to catch sediment-laden runoff from swales, small ephemeral drainages, or along hill slopes. They provide temporary sediment storage and cannot handle large debris flows or heavy sediment loads.

Water repellent soils.

Water repellency slows the movement of water through soil and results in altered substrate water recharge, quicker stream flow delivery, and increased potential for surface erosion. Wildfire creates water repellent layers by partially volatilizing soil organic compounds that then condense onto soil particles deeper in the soil profile.

To check for water repellent soil, scrape away the ash layer, exposing mineral soil. Place one drop of water on the soil surface. If water droplets bead on the surface for 10 to 40 seconds, it is considered moderately water repellent. If it beads for more than 40 seconds, it is considered strongly water repellent. Sometimes the water repellent layer is a few inches under the soil surface. In these cases, scrape away a ½ to one inch of soil and repeat the test to find the upper boundary of the water repellent layer. Continue testing the soil by scraping away additional layers of soils (½ to one inch at a time) until non-water repellent soil is reached. This will give you the location and depth of water repellent layers. Water repellency is more severe on dry, sandy soils, and occurs least on wet, fine textured soils. Areas of high severity burn are more likely to have fire-induced water repellency.

Fallen logs can be placed across slopes to slow runoff and intercept sediment, while hand rakes or hoes can been used on gentle to moderate slopes to break up water repellent layers and allow infiltration. On steeper slopes, scatter straw mulch to protect soil from erosion.

Seeding and Revegetation.

Though not the most successful, grass seeding is the most commonly used treatment after a burn. Grass seed is applied to burned sites from the ground or by air with the intention of increasing vegetative cover on the site during the first few critical years after a fire and by doing so, decreasing or preventing erosion. Grasses are particularly suited for this purpose because their extensive fibrous root systems increase water infiltration and hold soil in place. This treatment is able to treat large areas at a reasonably low cost per acre, and for decades was used for range improvement with the purpose of gaining use from land that would not produce timber for many years.

Seeding treatments may not be needed as often as currently thought, and successful establishment can actually displace native plant regeneration. As one of the most used and most studied treatments used by the Forest Service's Burned Area Emergency Response (BAER) teams, a great deal is known about the effectiveness of grass seeding. Erosion was decreased by seeding in only one out of eight (12.5 percent) first year studies; benefits were not apparent until the second year after a fire and had greatest value during the second and third rainy seasons. Forest silviculturalists have also expressed concerns about the impacts of grass seeding on conifer regeneration. Using native grass species over non-native annuals such as cereal grains does not necessarily evade this problem. Not only are native grasses expensive and not widely available, but well-adapted native perennial grasses could provide as much or more competition with tree regeneration as the non-native annual species currently in use.

If you decide to seed grass, know that the success of this treatment is highly dependent on the timeliness of seed application, choice of seed, applicator skill, protection from grazing, and luck in getting gentle rains to stimulate seed germination before wind or heavy rains blow or wash soil and seed away. Often times the most successful grass crops are often where they are needed the least – on gentle slopes and in riparian areas. Many have observed lush expanses of grass in drainage bottoms established from seed washed down adjacent slopes by the first storm events following a burn.

Aerial seeding grasses, and occasionally legumes, is typically done over large areas where erosion hazard is high and the native plant seed bank is thought to be destroyed or severely depleted by fire. Seed is applied by fixed-wing aircraft or helicopter. In some situations it is best to drop seed directly into dry ash before any rain falls, while in others, seed is best applied after the first snow so that it will germinate in the spring. Both of these conditions, as well as applying straw mulch over seeded grass can reduce loss of seed to rodents, increase available moisture for germination and growth, and protect seed from being washed or blow off site. Arranging for aerial application of seed in a timely manner after a burn can be difficult as there are few aircraft operators in any given area and supply may not equal demand. Obtaining a sufficient supply of seed, especially if you want or need to use native grass species, can also be difficult, and in the case of native species, expensive as well.

Broadcasting seed from all-terrain vehicles or by hand is less expensive and is commonly done in localized areas of high burn severity where reestablishing plant cover quickly is essential, such as riparian areas and above lakes and reservoirs. Broadcast seeding delivers a more even application than aerial seeding.

Hydroseeding is an application of a slurry of water, wood fiber, seed and fertilizer to treatment sites. Hydroseeding is best used on short, steep, highly erodible slopes that have been partially or completed denuded of vegetation. It is fairly expensive and is often reserved for areas close to roads, bridges, homes and other structures. Slope lengths of 100 to 200 feet can be treated. Small landowners will need to hire out this service – check listings in the yellow pages under landscape contractors.

Seed Mixes.

Fast-growing, annual or perennial non-native grasses and cereal grains are typically used. These species are inexpensive and regularly available in large quantities. Cereal grains such as barley, rye, oats, and winter wheat appear to show great promise for producing cover that does not persist. Legumes are able to increase available nitrogen in the soil after postfire nutrient flushes and are often added to mixes.

BAER teams have recommended non-reproducing annuals, such as cereal grains or sterile hybrids that provide quick cover and then die out in order to let native vegetation reoccupy the site. There are legitimate concerns that grass seeding may introduce weed species even in certified seed. For example, cheat grass can germinate and become established while lying on top of the soil and germinates earlier than other grass species, giving it a competitive advantage.

When considering grass seed mixes, first determine why you are reseeding the area (see *Table 10. Revegetating Burn Areas West of and Foothills/Mountains East of the Continental Divide* on page 6). Different mixes will be used for erosion and noxious weed control than for establishing range to graze cattle or for planting with trees. For example, if you are planting trees you will want to seed shorter grasses, as taller grass species tend to lay down on seedlings when wet or covered with snow and bend the seedlings over. You may also want to choose bunch grasses versus those that grow in thick mats. Voles and mice thrive in the protective covering provided by matting grass species while they eat your seedlings.

Planting several species of grasses and forbs allows you to cover a range of site conditions and increases your chance for success. The NRCS recommends a minimum of three species in a mix. Use certified seed of a known variety and make sure it is also certified as weed free. Fertilization is not recommend the first year of seeding, but should be done in subsequent years until vegetation is established.

To calculate a mix, divide the individual species rate by the number of species in the mix. Then take the lbs./acre and multiple by the total acres to be seeded.

***Example**:* Mix of five grasses to be seeded on 10 acres. Divide the lbs./acre for each species by five and then multiply by 10. For slender wheatgrass this would be (12/5) 10 = 24.

Contact your local Extension, state lands, Natural Resource Conservation Service (NRCS), or USDA Forest Service office for further information about grass seed mixes appropriate for your area.

Installation. The best time to seed is late fall before winter rain or snow begins. If mulching, apply straw at a rate of one ton per acre and anchor by punching with shovels or crimping equipment. Note that a 74-pound bale of straw will cover about 800 square feet.

The Natural Resource Conservation Service (NRCS) recommends the following steps for grass seeding:

Step 1: gather equipment and materials.

- One-hand operated cyclone spreader for each person.
- A scale to weigh the seed - at east 20 lb. capacity.
- At least two plastic buckets.
- Seed targets. At least two pieces of two x two foot soft cloth or cardboard with corrugations exposed, nailed to a wooden frame, or at least four pieces of one x one foot soft cloth attached to an open wire.
- Four grocery bags and two markers.
- Inoculant (specific type for each legume). Omit if seed is coated by supplier. Inoculating legumes enables them to fix nitrogen, which improves the plant health and also provides additional fertility for other plants. Inoculate alfalfa and other legumes the night before or early on seeding day so seed will be dry by seeding time. Re-inoculate seed coated over 30 days ago or any seed that has not been kept cool and dry.

Step 2. Purchase seed.

The total amount of seed needed will equal the acres burned multiplied by the recommended seeding rate per acre. Include roads and firebreaks in the burned areas. Seed supplies of each species should be obtained in separate bags and kept cool and dry.

Check seed tags for species and the percent germination and purity. Increase the seeding rate if percent germination multiplied by the percent purity shows less than 80% Pure Live Seed (PLS).

> *Example 1.* Low PLS adjustment. Recommended seed rate is 10 pounds per acre. The seed you bought is 90% pure and has a 70% germination rate.
>
> *90% x 70% = 63% Pure live seed*
> *Adjustment factor is 90/63 = 1.3*
> *Adjusted seeding rate is 1.3 x 10 lbs./acre = 13 lbs./acre*

Coated seed adjustment is needed if the seed is coated by the supplier with inoculant or other materials. No adjustment is needed when you inoculate alfalfa or other legume seeds at the site. Recommended seeding rates are based on uncoated seed and need to be adjusted as shown in this example after making any adjustment for low PLS:

> *Example 2.* Alfalfa seed or other small legume seed.
>
> *Adjustment factor = 1.5*
> *Adjusted seeding rate is 1.5 x 9 lbs./acres = 13.5 lbs./acre*

Step 3. Calibrate your spreader.

Adjust seed spreader according to the manufactures directions based on half the seeding rate when doing arid seeding and on the full rate when doing a single once-over seeding (see *Figure 13. Calibrating your spreader* on page 7).

Table 1. Revegetating Burn Areas West of and Foothills/Mountains East of the Continental Divide.

Zone 1 - Dry, warm sites. Open grasslands and woodland benches at low elevations on all aspects and on south- and west-facing slopes at higher elevations and dry Douglas-fir and ponderosa pine habitat types with significant bunch grass component in the understory.
Native tree and shrub species.
Trees: ponderosa pine, Douglas-fir.
Shrubs > 4 ft.: mountain mahogany, mockorange, chokecherry.
Shrubs < 4 ft.: snowberry, Woods rose, antelope bitterbrush, skunkbush sumac.

Grass/Forb species	lbs(PLS) ac@40 seeds/sq.ft.*
slender wheatgrass	12
thickspike wheatgrass	12
streambank wheatgrass	11
bluebunch wheatgrass	12
big bluegrass	2
pubescent wheatgrass	22
sheep fescue	3
hard fescue	3
yellow sweet clover	> 1/2 lb./ac.
dryland alfalfa varieties	> 1/2 lb./ac.

Zone 2 - Moist, warm sites. Moderate environments receiving more effective precipitation than dry, warm sites. Found on north- and east-facing slopes on lower elevations, all aspects at mid-elevations and on south- and west-facing slopes at higher elevations; Douglas-fir and ponderosa pine habitats.
Native tree/shrub species.
Trees: ponderosa pine, Douglas-fir, western larch.
Shrubs > 4 ft.: serviceberry, Rocky Mountain maple.
Shrubs < 4ft.: snowberry, Woods rose, currant.

Grass/Forb species	lbs(PLS) ac@40 seeds/sq.ft.*
slender wheatgrass	12
thickspike wheatgrass	12
streambank wheatgrass	11
beardless wheatgrass	12
big bluegrass	2
mounatin brome	27
intermediate wheatgrass	22
Nevada bluegrass	2
sheep fescue	3
hard fescue	3
orchardgrass	4
timothy	2
white Dutch, red or white clover	2
yellow sweet clover	> 1/2 lb./ac.
alfalfa	> 1/2 lb./ac.
sanfoin	> 1/2 lb./ac.

Zone 3 - Moist, cool sites. Found predominately on north- and east-facing slopes at mid-elevations and on all aspects at high elevations; Douglas-fir with blue huckleberry in understory along with grand fir, western redcedar, western hemlock habitat types.
Native tree/shrub species.
Trees: Douglas-fir, western larch, Engelmann spruce.
Shrubs > 4 ft.: Scouler's willow, red-osier dogwood, alder, Rocky Mountain maple.

Grass/Forb species	lbs(PLS) ac@40 seeds/sq.ft.*
slender wheatgrass	12
beardless wheatgrass	12
big bluegrass	2
tufted bluegrass	1
Mounatin brome	27
intermediate wheatgrass	22
orchardgrass	4
sheep fescue	3
hard fescue	3
Nevada bluegrass	2
timothy	2
Alsike, red or white clover	> 1/2 lb./ac.
birdsfoot trefoil	> 1/2 lb./ac.

Zone 4 - Riparian areas. Stream bottoms, wet meadows; these sites are sub-irrigated or wetter for at least a portion of each growing season.
Native tree/shrub species.
Trees: black cottonwood, quaking aspen, Engelmann spruce.
Shrubs > 4 ft.: native willows, red-osier dogwood, chokecherry, mockorange, Rocky Mountain maple, water birch, alder, serviceberry.
Shrubs < 4ft.: snowberry, Woods rose.

Grass/Forb species	lbs(PLS) ac@40 seeds/sq.ft.*
slender wheatgrass	12
basin wildrye	2
meadow foxtail	2
birdsfoot trefoil	> 1/2 lb./ac.
Alsike clover	> 1/2 lb./ac.

***Seeding rates by zone.** Rates are "pure stand" seeding rates for each species, expressed as pure live seed (PLS) per acre. **Rates should be doubled for severely burned areas.**

This information is excerpted from Wiersum, T., J. Fidel and T. Comfort. 2003. Revegetating after Wildfires. NRCS, Missoula, MT.

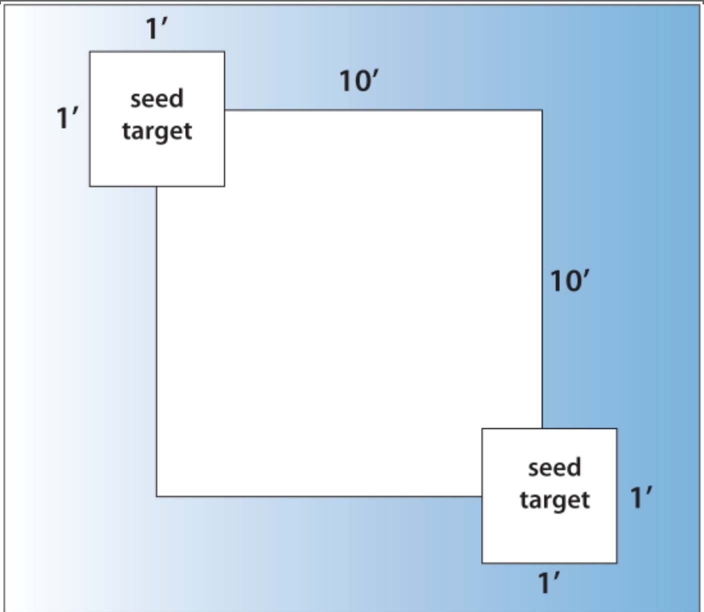


Figure 13. Calibrating your spreader.

- Set out two seed targets 10 feet apart and offset 10 feet.
- With the hand-operated spreader half full, start broadcasting and walk between the two seed targets.
- Stop and check the seed count at each target. Adjust the spreader and repeat until the number of seeds per square foot agrees with your approximate target of a minimum of 50 seeds per square foot.

Step 4. Seeding.

Divide seed of each species into equal amounts and label bags. Keep cool and dry. When seeding a mixture broadcast each species separately, if possible, to get the most uniform distribution of seed.

- Broadcast in two directions to achieve uniform distribution of seed. Using half the seed of a species, broadcast as you walk across the slope, starting at the top of the burn area. Maintain the same walking speed you used while calibrating your spreaders. Notice how far the seed is thrown. When you reach the other edge of the burn, move downslope a distance equal to the width of the throw and make another pass across the slope. Continue broadcasting half of the seed, trying to avoid gaps. Repeat until you reach the bottom edge. If you have several people seeding move across the slope together, adjust your walking pace so you have enough seed to finish.
- Using the remaining half of the seed, repeat the process going down the area. On gentle slopes you may be able to broadcast while walking back up the slope. On steep slopes it is best to broadcast only while walking down the slope because you need to maintain the same walking speed used to calibrate the seeder.
- If you are only able to broadcast in one direction, broadcast half of the seed first and then the other half in the same direction while walking midway between your previous lines of travel.

Visual monitoring should be done for several years after a burn. Temporary fencing may be necessary to keep grazing livestock and wildlife and/or vehicles off of burned areas and riparian zones during recovery periods. In some areas, elk grazing is as problematic as cattle grazing, and the use of the more costly high fences that exclude elk needs to be considered. Elimination of grazing for two years was judged to be very important for achieving hill slope stability.

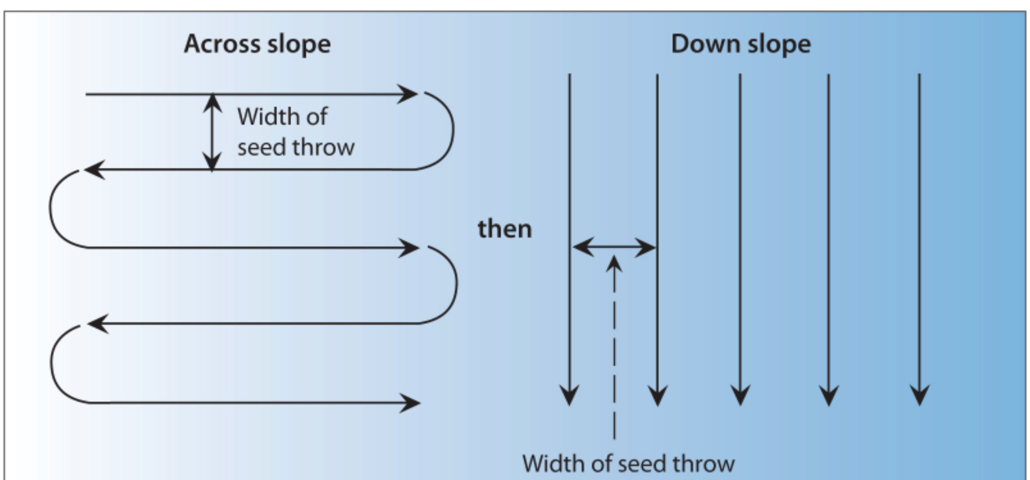


Figure 14. Broadcast seeding in two directions.

Channel treatments

Channel treatments are used to control sediment and water movement in ephemeral or perennial stream channels and to prevent flooding and debris torrents. Some in-channel treatments slow water velocities, allowing sediment to settle out and be released gradually as the structure decays; others provide longer-term protection.

It is felt that channel treatments should be viewed as secondary mitigation treatments and should only be used if downstream threats are severe. Most channel treatments are expensive and will need to be installed by qualified engineers. In some states permits may be necessary to do any in-channel treatments. Check with your state lands management agency for the rules.

Barriers.

Straw bale check dams. Straws bale check dams are temporary sediment barriers constructed of straw bales located across small drainages. These temporary structures decrease water velocity and detain surface runoff long enough for sediment to filter out and be deposit behind dams, thereby reducing the amount of sediment deposited into stream channels.

Straw bale check dams are a very temporary treatment (often filling in after the first few storms) and should not be expected to provide protection for longer than three months. Straw bale check dams have been shown to work best in drier regions, on small drainage areas that have low gradients (less than 30%), and in channels that are not incised. They are not intended to provide protection from large storm events or to control debris flows in larger creeks, streams, or rivers. Timing of installation can be dependent on the availability of straw bales, which is often not until August of each year. Again, use certified weed-free materials to prevent establishing weeds at and downstream from the structure site.

Straw bale check dams tend to blow out in large storms and failure is common in poorly installed or located structures. To be effective, straw bale check dams must be well designed, properly placed, and well built.

Straw bale check dam.
Photo by © Karen Wattenmaker Photography

The dam will consist of two rows, an upstream row and a downstream row (see Figure x (1)).

To install straw bale check dams across small channels:

Downstream row:

- Dig a trench across the channel of a size that will result in the top of this row of bales being level with the ground (see Figure x (2)). Straw bales in this row will be placed with the longest, widest side down.
- The tops of the bales across the center of the channel should all be level and set at the same elevation. Stake bales after all bales have been placed into position (see below).

Upstream row:

- Dig another trench across the channel, upstream and immediately adjacent to the downstream row of bales. This trench needs to be wide and deep enough for the straw bales to be placed vertically on their long edges with at least six inches of each bale below the ground, starting with the bale in the middle of the channel (see Figure x (3)).
- The trench should be as level as possible so the tops of the bales at the center of the channel are level and water can flow evenly across this portion of the dam.
- Continue the trench up the side slopes of the small channel to a point where the unburied bottom line of the highest bale (point "C" in Figure x (4)) is higher than the top of the bales that are in the center of the channel (point "D" in Figure x (4)).

Anchoring the structure:

- After you have placed the bales to your satisfaction they need to be staked. Drive two-inch by two-inch wooded stakes or number four rebar stakes through the bales and one and a half- to two-feet into the ground. The first stake in each bale should be driven toward a previously laid bale to force the bales together (see Figure x (4).

First year maintenance is critical. Inspect your straw bale check dams after each precipitation event and do necessary repairs immediately.

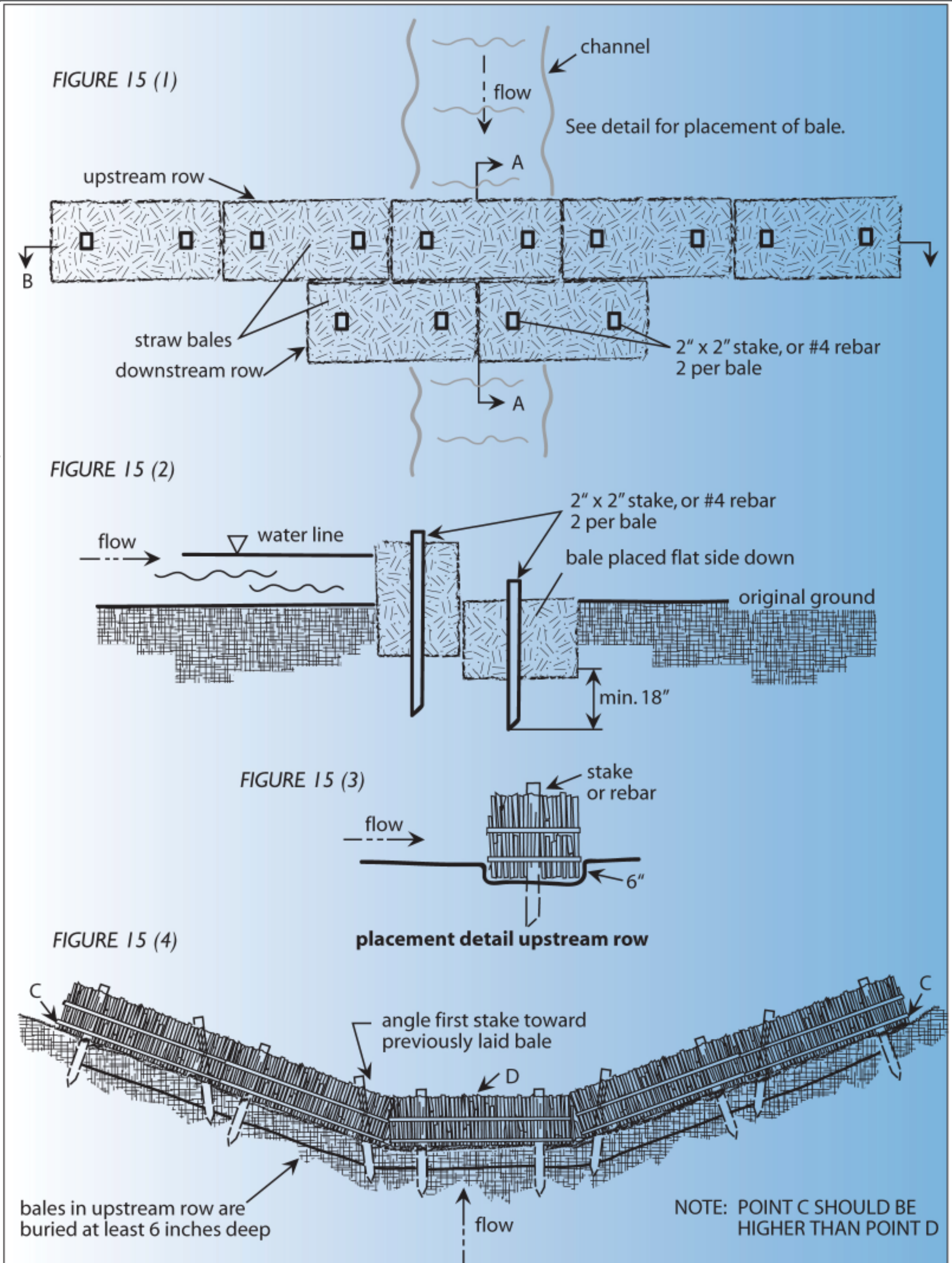


Figure 15. Straw bail check dams.

Log check dams. Log check dams provide the same protection as straw bale check dams, but have the added benefit of being more durable than straw bales and lasting much longer. Research has shown that well-built log dams can be 70 to 80 percent effective in trapping sediment and last 15 to 30 years.

Rock cage dams (gabions). Rock cage dams, also known as gabions or rock fence check dams, are used in intermittent or small perennial stream channels to replace large woody debris that was removed from stream environments by fire. Rock cage dams provide grade stability and slow the flow of water enough to trap coarse sediments. This treatment works well on mild gradients, and often will trap enough fine sediments behind the structure to provide a microsite for riparian vegetation reestablishment.

Properly designed and installed rock cage dams are capable of halting gully erosion in denuded watersheds and reducing sediment yields by 60 percent or more. Although these structures are relatively expensive, studies have shown that when used in conjunction with vegetation treatments they can reduce erosion by 80 percent and suspended sediment concentrations to 95 percent. Installation will depend on the availability of adequate amounts and sizes of rocks, and due to the weight of the cages when filled, should be installed by a commercial contractor. Rock cage dams need to be cleaned out periodically to maintain their effectiveness.

Log grade and rock grade stabilizers. These structures are similar in function to log dams, but the emphasis is on stabilizing the channel gradient rather than trapping sediment. They are expensive and time-consuming to install. Proper design and installation are critical in making log grade stabilizers last and function effectively.

Channel or stream clearing.

Channel clearing is done to remove large objects that could become mobilized in a flood. Removing and/or reducing the size of logs and other organic debris and removing sediment deposits from stream channels prevents this material from being mobilized in debris flows or flood events. This treatment is used to prevent the creation of channel debris dams, which can contribute to flash flooding, as well as decrease or eliminate organic debris that can block culverts and cause culvert failure or reduce channel flow capacity.

In many cases, debris from fire-killed trees does not enter channel systems until two to three years after a burn. Large woody debris plays an important role in stream environments by trapping sediment, dissipating the energy of flowing water, and providing aquatic habitats. In some instances, channel clearing can be more disruptive than the wildfire, and policy is swinging towards reducing the use of or eliminating this practice.

Channel clearing is an expensive and time consuming operation, and should be reserved for situations where other methods cannot be used to protect road culverts, where woody debris might move into reservoirs, and where sediment must be removed from debris basins and channels to provide adequate sediment storage capacity.

In-channel felling.

In-channel felling of streamside trees can provide small sediment trapping structures and large woody debris that traps organic debris and temporarily detains or slows down storm runoff. In-channel felling is commonly done in headwater streams using walking type excavators to place large woody material across the channel where existing wood was consumed by fire.

When falling trees in-channel, tree roots should remain attached and should be partially buried. This will ensure the successful placement of the structures and prevent them from washing downstream. Large woody material diameters should range from 12 to 16 inches with a length of approximately 40 feet or more. Woody material felled into channels will often alter stream gradients, and may cause sediment deposition and channel aggradation.

Debris basins.

Debris basins are constructed to regain control of runoff or decrease the deterioration of water quality and threat to human life and property. Debris dams are designed to provide immediate protection from floodwater, floatable debris, sediment, boulders, and mudflows. Effective debris dams must be able to trap a minimum of 50 percent and preferably 70 to 80 percent of 100-year flows. A spillway is a necessary part of the construction to insure the safe release of flows in excess of the design storage capacity. This treatment is often used as a last resort because they must be designed by qualified engineers, are extremely expensive to construct, and require annual maintenance.

Road Treatments

While many road drainage systems are usually not affected by fire, adjacent, altered watersheds can affect the functionality of these systems. Road treatments are used to manage and mitigate water's erosive force and move water to from undesirable to desired locations. Landowners may need professional assistance to properly design road treatments.

Culverts, culvert overflow/bypass, rolling dips, water bars, cross drains.

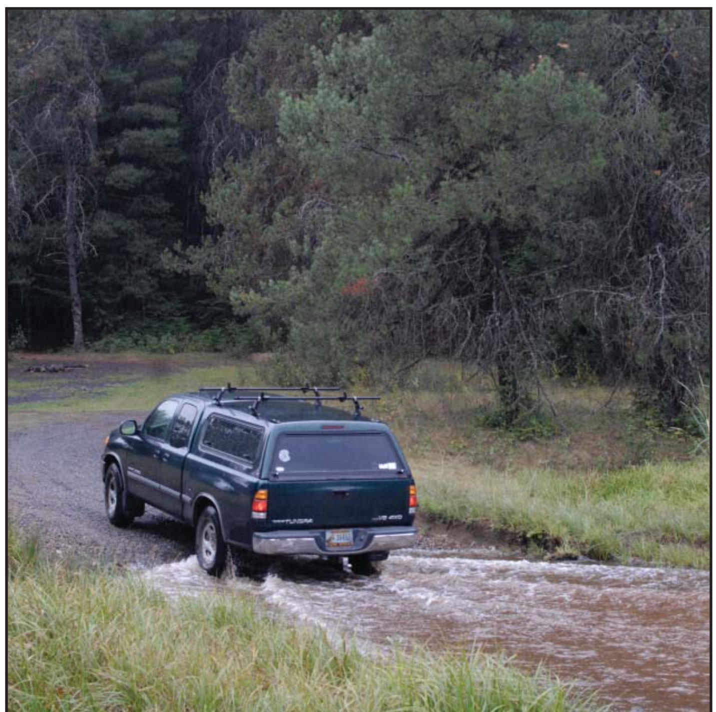
All of these treatments are used to provide drainage relief for roads and inside ditches to the downhill side of roads, especially when existing culverts are expected to be overwhelmed. Most landowners will need to hire a commercial contractor to repair and maintain forest roads, especially permanent roads and those that experience heavy and/or seasonal use.

Increasing culvert sizes increases flow capacity and decreases potential for road damage. Installing and maintaining armored culvert inlets and outlets not only maintains flow, but also reduces scouring around culvert entrances and exits, allows large particles to settle out of sediment laden water, and reduces the chance of debris blocking culverts. In some cases, removing undersized culverts, which will fail with increased flows, is the best option. Culvert removal, instead of upgrade, is often done when roads are removed. Frequent storm patrols to check culvert performance are a cost effective method to reduce road failure due to culvert blockage, and also enable you to close areas as needed. Some areas include early warning systems such as radio-activated rain gauges or stream gauge alarms when flows are increased. Check with your local Fish and Game agency for fish passage considerations.

Ditches and armored crossings.

Cleaning and armoring ditches will aid water flow capacities and prevent down cutting. Ditches need to be maintained or high water levels can overtop roadways leading to gully development in the roadbed. Armoring ford crossings provide low-cost access across stream channels on low traffic volume roads and are able to handle large flows. Large riprap is placed upstream and downstream of the actual road crossing area.

Culvert inspection.
Photo by R. Barkley, Idaho Department of Lands.



Armored stream crossing.
Photo by Y.C. Barkley,
University of Idaho Extension.

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