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Natural Resources Conservation Service

after the fire

Post Fire Restoration

Preparing for Winter Following Fire

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The sound of falling rain this winter may take on a whole new meaning for those who either suffered property damage from wildfires or who live directly downstream of fire damage watersheds. If you are concerned about the possibility of erosion, mudslides, flooding or other related winter storm impacts following fire then the following 10 Basic Rules may help you prepare and safeguard your properties and families during future winter storm and runoff events.

10 Basic Rules

1. Keep it under cover. Protect existing plant cover and establish vegetative cover (or other protective cover such as mulch) on all bare or disturbed soil and slopes immediately around your home and other property improvements before the winter rains. Plant materials and different types of mulches can be used to protect soil and slopes from the impact of falling rain and storm water runoff. *Note: Seeding and/or mulching is not recommended in wild land areas but may have some application on soils disturbed by dozers and along side access roads and driveways if recommended by an appropriate professional, such as a native plant specialist. Grass and/or plantings should be native or non-invasive non-native plant materials.*

2. Do not disturb soil and slopes during the rainy season. Slopes and soil are more susceptible to instability and erosion when vegetation is removed or disturbed and when soil becomes saturated.

3. Drainage facilities and potential runoff impacts on private roadways, long driveways and even fire breaks, especially in fire damaged areas, need to be evaluated. Runoff control treatments including protective release points may be needed to protect down slope areas from erosion, slope failure and flood hazards. Consider the following 4-D formula when dealing with drainage and runoff issues.

a. Decrease volumes and/or velocity of runoff by providing velocity dissipation (rock or other prepared outlets) at culvert and drain outlets and breaking up large volumes of runoff coming from roof tops and landscape into smaller less erosive forms.

b. Detain runoff and meter over time or store for later use to lessen impact on saturated soil and slopes during peak storm events. Detention basins, rain gardens, and water harvesting systems are all ways to detain runoff.

c. Dissipate runoff where ever concentrated flows come in contact with bare soil and/or steep slopes by installing practices (vegetation, mulch, rock aprons, etc.) that spread runoff and help reduce both erosive capacity of soil and runoff volumes. Install velocity dissipaters at all culvert and drain outlets to prevent soil erosion. *Note: Road culverts may need to be extended to a safer discharge point if culvert outlets have been denuded by fire.*

d. Divert runoff if all else fails. Use this “D” with extreme caution. It may be helpful to re-route runoff and drainage away from unstable slopes, eroded areas, unprotected soil, etc.

Post Fire Restoration

10 Basic Rules

4. Monitor and maintain all existing and planned runoff, erosion and sediment control measures (including vegetative cover) before and throughout the rainy season. Correct deficiencies as soon as possible. In some areas, leaf litter may be a serious problem for roof, driveway and landscape drainage systems because of all the fire and heat damage done to evergreen vegetation this year. Properly designed, located, and installed trash racks, debris barriers, gutter guards and other similar devices will help to reduce maintenance and allow home and property drainage systems to function properly.

5. Use emergency/temporary practices such as sand bags, brush and slash, plastic sheeting, and hand-dug drainage ditches, etc. with extreme caution or don't use at all. Do not install without professional guidance. For example: covering slopes with plastic sheeting or dumping brush into gullies or other eroded areas is almost always the wrong thing to do. An improperly designed or placed emergency practice can be worse than no practice at all. Additionally, emergency measures may cause new hazards or problems and provide a false sense of security.

6. Prune or remove high hazard fire damaged trees capable of falling on to living structures or roads before winter storms. *Note: Don't remove healthy or slightly damaged trees unnecessarily. Tree root systems are still holding soil and slopes in place and tree cover is protecting soil from impact of falling rain as well as reducing winter runoff. Consult with Cal Fire and/or a registered professional forester (RFP) or certified arborist for assistance. Contact Forestry hotline at 800-738-TREE (8733); forestryhelp@gmail.com for a list of RPFs or certified arborists.*

7. There is an increased threat of rock fall in some areas because of damage to vegetation and shallow rocky soils and slopes in affected watersheds. Debris barriers and rock fall netting can be effective in capturing smaller rocks, but larger rocks will require more substantial measures. If there is a threat of large rocks releasing from slopes on your property or adjacent properties, then seek professional assistance. Contact the USDA Natural Resources Conservation Service or the resource conservation district.

8. Get professional help with design and installation of any temporary or permanent practices to control runoff, prevent an erosion problem, or address a slope stabilization concern.

9. Work with neighboring property owners when determining permanent solutions for drainage and runoff issues. Runoff normally extends beyond property lines. You may be liable for both controlled and uncontrolled releases of collected runoff on to down slope neighboring properties if you decide not to be concerned with potential off site impacts.

10. Be prepared and don't stay in your home when it becomes unsafe. Have a home and neighborhood evacuation plan. Have an emergency plan for your pets and livestock as well. Stockpile emergency supplies including sandbags, a supply of sand, straw, etc. Pay close attention to weather forecasts, flash flood and storm warnings, water levels in nearby creeks, etc. throughout the winter. Monitor property rainfall with a rain gauge. Evacuation plans should always include at least one alternative escape route and a list of important/emergency numbers, including numbers of neighboring property owners.

Roadway related problems, flooding, existing gullies and eroded areas, including stream bank erosion are all likely to appear or get worse this first winter following fire. Sediment levels in creeks and waterways are expected to rise, reducing channel capacities and increasing the likelihood of flooding on properties and down stream. *Note: If flooding and/or mudslides occur and impact road surfaces, do not attempt to drive over flowing water or mud.*

Some signs of impending danger from debris flows, landslides and severe erosion or imminent flooding include: an intense storm event (1-2 inches per hour), especially following previous rainfall that caused ground saturation; water flowing over the landscape where it hadn't appeared in previous winters; leaning or falling trees; tension cracks along the top edge of slopes and along driveways and roads; seeps or increased spring activity in slopes; severely disturbed and unprotected slope areas caused by firefighting efforts or from recent activities to remove fire damaged trees and other slope holding vegetation.

For more information, helpful publications, fire hazard retardant erosion control plant lists, drainage control and road maintenance guides or other natural resource information for your property contact the USDA Natural Resources Conservation Service or resource conservation district.

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Hillside Home Drainage

CAUTION: After a fire many trees are weakened from burning around the base of the trunk. The trees can fall over or blow down without warning. Shallow-rooted trees can also fall. Therefore be extremely alert when around burned trees.

Drainage tips for hillside homeowners:

Hillside lots that have been damaged by fire or are located in a fire-damaged watershed can be susceptible to erosion, drainage and other runoff related problems. Torrential or prolonged rains cause the most damage. To treat surface drainage problems, you will first need to identify the sources of surface water (runoff) flowing onto or over your property. Walk outside and around your home. As you walk, observe the "lay" of your lot and the surrounding properties. Also, observe your roof and driveway. Is your home on top of a hill where all surface waters drain away from your home? If so, you will be concerned with holding topsoil on your property. Few homeowners live on top of a hill. So, it is more likely that water will flow onto your property from an adjacent hillside. Where will the water concentrate and how can you control the sediment that is carried with the water?

Gutters and downspouts direct roof runoff:

Be sure that your roof is properly fitted with gutters and downspouts that will release water onto a non-erodible surface such as a paved driveway. Or you can connect downspouts firmly to solid plastic pipe that will carry water down slope away from your home to a place where it will be released safely such as a paved roadside or storm drain ditch. Because twigs, pine needles and leaves can clog gutters and downspouts, the use of gutter guards of 1/4 to 1/2-inch hardware cloth screen is highly recommended. Clear your gutters regularly and inspect them to ensure your roof runoff system is working properly.

Hillside Home Drainage

Curbs and berms protect sensitive slopes:

A concrete curb, a compacted earth berm, or other similar structures on the outside edge of a driveway or building pad can direct runoff away from sensitive slopes to an area where it can be released safely. The recommended height of the berm is a minimum of
12-18 inches. (see other fact sheets for information on temporary flood barriers). A pipe drop may be used to carry runoff down slope to a place where it can be released safely, such as a lined roadside ditch or storm drain.

Lined ditches handle road & driveway runoff:

Roads and driveways can be graded toward a lined ditch or street side gutter designed to handle sheet flow water from paved surfaces and uphill slopes. At specific intervals along the main road, water may be transported under the road through a culvert and released safely onto a non-erodible surface. An energy dissipater, such as a rock lined outlet, can serve this purpose where slope is minimal. In steeper areas or where large volumes of water may accumulate, other precautions may be needed to prevent wash-outs or localized flooding.

Proper grading promotes good drainage:

Proper grading of your land helps prevent water from pooling around foundations, flooding basements or below grade structural components, and concentrating water into destructive volumes. In general, grade surfaces around a home so runoff flows away from foundations at a minimum slope of 1-2 feet for every 100 feet. Grade and compact surfaces evenly since water can collect in depressions or channelize into destructive flows.

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Hydromulching

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What is hydromulching?

Hydromulching is spraying a mixture of water, fiber mulch, and tackifier on burned slopes to prevent soil erosion or foster revegetation. Seed, fertilizer, or soil stabilizing polymers may also be applied with the hydromulch.

When is hydromulching used?

Hydromulch is used on severely burned or otherwise highly erosive areas with 20 percent to 60 percent slopes. Hydromulching is an expensive erosion control method and therefore is generally limited to treating high risk areas to protect valuable properties, surface water supply sources, or important habitat. Due to its expense, conventional mulching is generally used on slopes less than 20 percent. Use of ground applied hydromulch is limited to areas within 300 feet of the roads or trails that are necessary to provide access for the application equipment.

Uniform aerial application of hydromulch is difficult to accomplish and as a result has proven less effective for erosion control, so it is seldom recommended. Hydromulch is generally not recommended where there is more than 25 percent surface rock cover, in areas where there is appreciable needle-cast, or where there is good potential for regrowth of vegetation within the first year after a fire.

Hydromulching utilizes a 1,000 to 3,000 gallon tank mounted on a truck or trailer that is equipped with a special pump and continuous agitation system. The pump forces the slurry through either a discharge nozzle mounted on top of the tank or a nozzle on the end of a hose. Hoses are typically limited to 200 feet in length. Fiber mulch and tackifier are added to the water in the tank and thoroughly mixed prior to application.

Hydromulching

Methods and Materials:

The type and amount of mulch and tackifier is selected to provide a minimum of 70 percent surface cover that will remain in place for at least one growing season. Application rates in the range of 2,000 to 3,000 pounds of wood fiber mulch and 75 to 100 pounds of Guar based tackifier per acre are typical. Fiber mulch has natural tackifying properties, but adding a tackifier is necessary to ensure the mulch remains in place when it is applied to burned slopes. Use of 500 to 1,000 pounds fiber mulch per acre and tackifier can be applied over loose, blown straw to tack it down where crimping is impractical.

The actual materials and application rates to be used at any location should be determined by erosion control experts with consideration for the specific site characteristics and the level of protection required.

Hyrdroseeding:

When seed is applied with the mulch (Hydroseeding) split applications are generally more effective than applying all materials in one pass. About 500 pounds of mulch per acre is applied with the seed (and fertilizer if recommended) in the first pass followed by a second application of 1,500 to 2,000 pounds of mulch and tackifier.

Safety concerns:

Ground hydromulching uses existing roads that may have other traffic. A road safety plan is needed to identify and explain how to mitigate traffic related hazards. Personnel applying hydromulch must wear the type and extent of personel protective equipment that is appropriate for the type and nature of material being applied. Fiber mulch is dyed to aid in uniform distribution, and care should be taken to avoid application on concrete, painted surfaces, or other structures/areas where mulch is not intended to be applied.

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Log Erosion Barriers

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What are Log Erosion Barriers?

Log Erosion Barriers (LEBs) are logs placed in a shallow trench on the contour to intercept water running down a slope and trap sediment. This treatment may also be known as contour log felling, log terraces or terracettes.

When are log erosion barriers used?

Log erosion barriers are used on moderate or severely burned slopes ranging between 20 percent to 60 percent, with erosive soils. LEBs are used where erosion rates have increased significantly because of the fire and there are high values at risk downstream. The site must have enough trees of adequate size to meet treatment objectives (at least 60 trees per acre). Soils can be shallow, but not less than about 8 inches. LEBs increase infiltration, add roughness, reduce erosion, and help retain small amounts of eroded soil on site. LEBs should be effective for a period of one to two years, providing short-term protection on slopes where permanent vegetation will re-establish and provides long-term erosion control.

Materials needed:

- 6-12 inch diameter logs, 10-30 feet long
- An expert sawyer and labor crew with hand tools
- Machines may be used for moving logs or trenching them in on 30 percent or flatter slopes

Log Erosion Barriers

How are log erosion barriers installed?

A contour line is marked on the slope to identify the approximate cross slope alignment. Trees along this line are felled on the upstream side of the contour line as much as possible. Stumps are left about 12" high to brace the tree. The logs are cut to a length that permits safe handling and placement for the crew, generally 10 to 30 feet. Tree limbs are removed to the extent necessary for the log to lie flat on the ground. A shallow trench (about 4 to 6 inches deep) is dug along the contour. The log is placed in the trench and seated with tamped backfill such that water flowing down the slope will not run under it. For this practice to be effective, enough trees must be felled along the contour line to create a semi continuous barrier to the movement of water down the slope, as shown in Figure 1 & 2.

Fig. 1 - Theoretical log terracing pattern

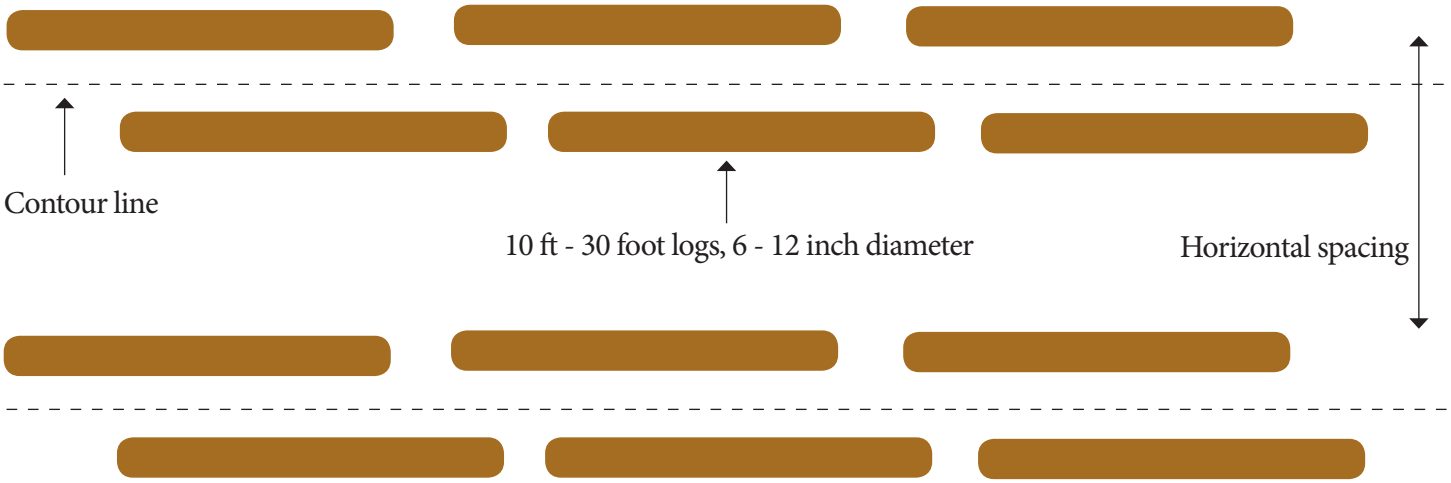
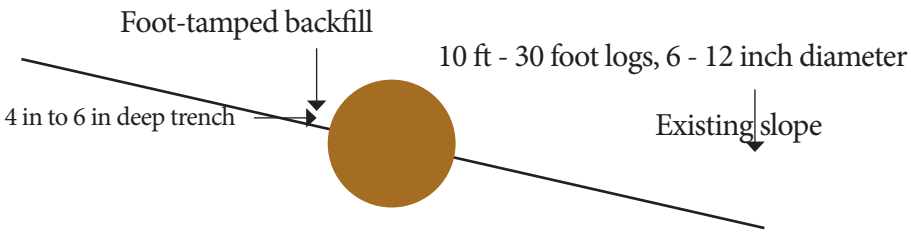


Fig. 2 - Typical log & bedding detail



Log Erosion Barriers

How many LEBs are required?

Depending on characteristics of the slope, somewhere between 60 and 152 trees per acre are needed for use of LEBs to be effective. Figure 1 depicts the pattern of LEBs on the slope, and Table 1 shows recommended spacing.

Table 1: Recommended spacing for contour slope treatments

Slope Steepness (percent)	Burn Intensity	
	Moderate	Severe
	Spacing (feet)	
10 - 20%	60	40
20 - 50%	30	20
>50%	15	10

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Sandbag Barrier

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What is a sandbag barrier?

A sandbag barrier is an inexpensive temporary wall, one to two feet high that is constructed by stacking sand-filled or earth-filled sandbags and placing them to divert mud and other debris flows away from buildings. These barriers do not provide protection from high debris flows.

When is a sandbag barrier used?

These barriers are used to protect building sites vulnerable to low mud debris flows from steep, erodible slopes that are partially or completely void of vegetation due to wildfire burns. This is an inexpensive, temporary protection method that can be used by homeowners before predicted rainfall. Sandbags deteriorate when exposed to continued wetting and drying for several months If the bags need to be used for more than a few months, cement can be mixed with the sand. The cement and sand mixture will harden when the bags dry.

How is a sandbag barrier installed?

These barriers are easy to construct using burlap or plastic bags, sand, plastic, lumber, cement and plywood. Sandbag Protection lends itself well to installation by volunteer groups and individual landowners.

Sandbag Barrier

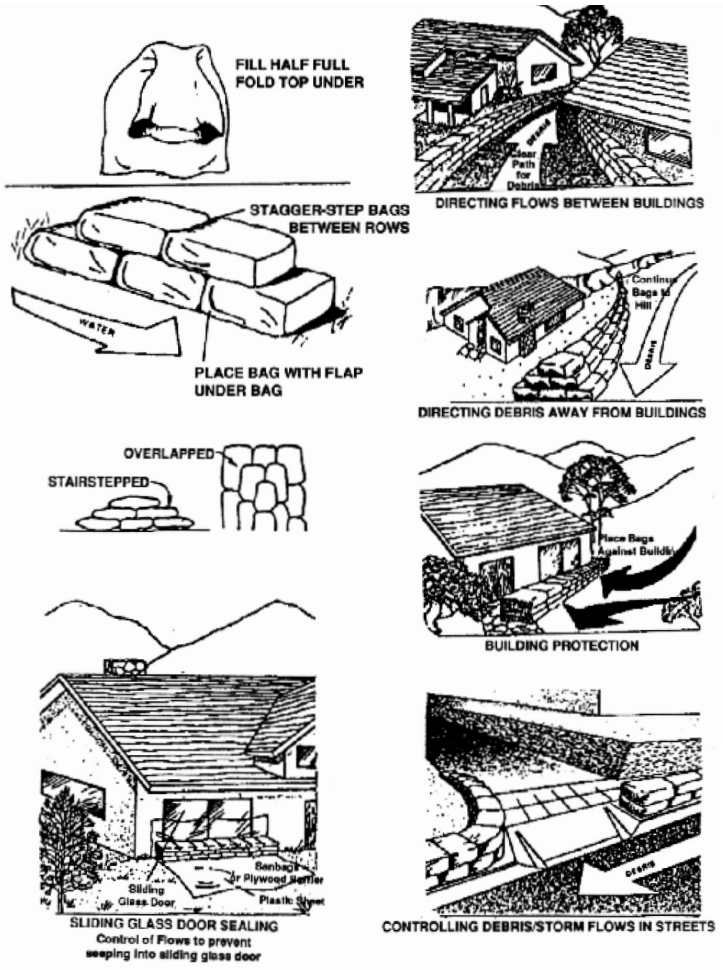
How is a sandbag barrier installed (cont)?

Selecting Treatment Areas: Begin by trying to direct debris flows away from buildings and other structures. Clear a path for the debris. Do not try to dam it or stop it. Protect your most valuable property first. Debris can enter a building through doors and windows. They should be boarded up and waterproofed with plastic sheets. Sandbags will not seal out water.

Filling Bags: Fill sandbags one-half full. Use sand, if available, or, local soil. Fold the top of the sandbag down and place the bag on its folded top (see illustration).

Placing Bags: Refer to the illustration. Place each sandbag as shown, finishing each layer before starting the next. Limit placement to two layers unless they are stacked against a building or sandbags are pyramided. It is important to place the bags with the folded top in the upstream or uphill direction facing the flow of water to prevent them from opening when water runs by.

Illustration: Sandbag filling and placement



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Seeding

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Why seed after a wildfire?

Loss of vegetation leaves land vulnerable to increased runoff, erosion, and sedimentation. It also encourages weeds; degrades habitat; and impairs forest regeneration. Re- establishment of permanent vegetation provides long-term erosion control, may restore lost habitat values, and may help suppress noxious weed invasion after a wildfire.

However it takes time and favorable climatic conditions to establish vegetation from seeding operations. Therefore it may be six months or a year before the full benefits of seeding are realized. Seeding must be combined with other land treatments, such as mulching, to provide an immediate erosion control benefit, and to assure the seed remains in place until it can germinate.

When is the right time to seed after a fire?

Seed grasses and forbs in late fall or winter (even if there are a few inches of snow). To improve the probability for a successful seeding, use a national or local weather services to time your seeding within 30 days of precipitation. The prime time to seed is immediately prior to the ground freezing. Trees or shrubs should be planted in the fall or early spring when plants are dormant.

Seeding

What areas need to be seeded?

Severely burned sites should be seeded to decrease the likelihood of erosion and sediment movement down slopes, to discourage weed invasion, or to fulfill management objectives.
The area to be seeded should have adequate soil to support vegetation. Seeding slopes steeper than 60 percent is difficult, and not especially effective for reestablishing permanent vegetation. These steep slopes may need the use of erosion control mats to keep soil and seed in place. These mats are expensive so use only on critical areas.

Vegetation in areas of light and moderate burn severity will recover on its own after a wildfire, and seeding perennial species is usually not necessary. Seeding a temporary species may provide some ground cover or reduce intrusion of weeds until the permanent vegetation can reestablish.

How should the seeding be done?

Most seeding are done by hand, use of self-propelled ground equipment, or by aircraft. Landowners can seed small areas using a hand-crank seed broadcaster. If there is access to the site and the slope is less than about 30 percent it is usually easier and more cost effective to seed areas larger than about 1-2 acres with broadcast seeders mounted on all terrain vehicles or tractors. Large contiguous areas lend themselves to aerial seeding, which can also be used on slopes that are too steep or otherwise inaccessible for use of ground equipment. Seeding included with a hydromulching operation should be considered when re-vegetation is essential to protecting high value properties immediately downstream of the area being treated. If fire seals or rain smooths soil surface, then it may be helpful for small areas to rake by hand and for larger areas to roughen up the surface mechanically (see *Mechanical Scarification*) prior to broadcast seeding, for improved success.

What variety of seeds should be used?

Perennial grasses and forbs are slower to establish, but provide long-term cover for reseeded sites. For example, slender wheatgrass is a native grass that establishes quickly and is moderately long-lived. Over time, as the slender wheatgrass begins to die out, other native species begin to fill in the site.

Small grains are useful when quick establishment is key; however, they only provide one year of protection. Revegetate with annual species where perennial grasses will recover naturally, including moderately burned sites with slopes greater than 15 percent. For severely burned areas it would be appropriate to include perennial species with the small annual grains. You should use certified seed of a known variety to get the best results. If a specified variety is not available, be sure the original seed (germplasm) source is within 200 miles north/south; 500 miles east/west; and 3,000 feet elevation of your property. Be sure seed does not contain any noxious weeds.

Seeding

What variety of seeds should be used?

Most seeding recommendations are seed drilling rates expressed in terms of pounds of pure live seed (PLS) per acre (PLS=%Purity x %Germination). Broadcast rates for burned areas should be at least dourble the drilling rates.

Contact the local NRCS, Extension Service, or conservation district office for recommended varieties and seeding rates.

What should be done along with the seeding?

Mulching will stabilize the soil surface to prevent movement of soil particles and loss of seed. Use straw or grass hay mulch. Apply mulch at 70 lbs/1,000 sq. ft. (about 43 bales per acre). Use weed free material. Do not fertilize the first year. Use netting to keep the mulch in place on small areas of steep slopes or erosion mats that act as mulch. Hydromulching and seeding is very expensive, but it can be accomplished in one operation. Maintain seeded areas by repairing any spots of failure with new seed and mulch if possible.

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after the fire

Hand Raking

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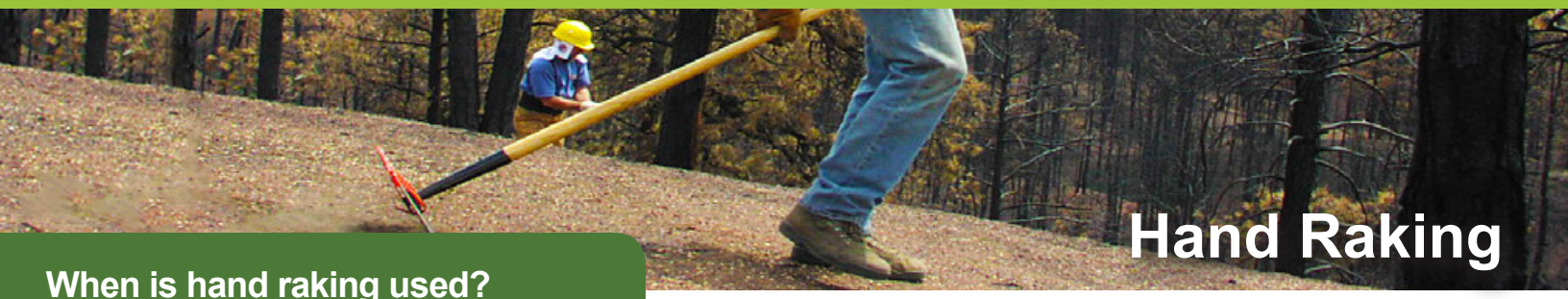
What is a hand raking?

Hand raking is a treatment performed by a crew of laborers using hand tools such as rakes, hoes, Pulaskis or McLeods to scarify or loosen the upper part of the soil profile. It can also be accomplished with light equipment such as an all terrain vehicle (ATV) pulling a harrow where there is sufficient access for the equipment and slopes are less than 30 percent.

When is hand raking used?

Hand Raking or light scarification is used on severely burned slopes with hydrophobic soil properties that will also be treated by mulching for erosion control, and may also include seeding to reestablish vegetation. It is primarily applicable to areas that are too small for efficient use of large machines, or are not accessible by machines due to slope steepness or presence of obstructions. The soil must be fairly loose to begin with such that it can be tilled with hand tools or a light harrow.

The primary use of this practice is to improve seedbed conditions immediately ahead of a seeding operation.



Hand Raking

When is hand raking used?

Hand raking does not till the soil deep enough to have any appreciable effect on infiltration of or reducing runoff. In cases where the fire has induced hydrophobic characteristics that exist only at or near the ground surface hand raking may have some benefit to reduce the hydrophobic effect by mixing affected soil with unaffected soil from deeper in the profile.

Hand raking increases the erodibility of the soil so it must be used in combination with erosion control treatments, such as mulching.

How is hand raking performed?

Laborers outfitted with rakes, hoes, Pulaskis, or other rugged hand tools, and appropriate personal protective equipment, loosen and mix the soil to a depth of 2 to 4 inches over the areas to be treated. On slopes of less than 20% with few obstructions light scarification can be accomplished with an ATV pulling a tined harrow.

The entire slope may be raked to achieve the maximum effect. To reduce treatment costs on large areas hand raking can be accomplished in 8 foot wide strips spaced uniformly over the slope. A contour line is marked about 1/3 the way down the slope to establish a key line.

The strips are marked and raked parallel to this key line. The maximum recommended spacing between strips is shown below:

Slope gradient (percent)	Raked strip spacing (feet)
< 5%	160
5 - 10%	120
10 - 20%	60
20 - 30%	30

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Concrete Barrier Wall

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What is a concretebarrier wall?

A strong temporary wall constructed of precast concrete barriers, such as "Ecology Blocks" or "Jersey Barriers," placed end to end to divert debris flows away from buildings or other important structures.

When is a concrete barrier wall used?

These barrier walls are used to protect buildings and other important sites with increased risk of flooding as a result of wildfires within the contributing drainage area. This is an expensive but stout protection method that can be installed quickly with heavy equipment and will last indefinitely. Temporary concrete barriers can be combined with diversion channels or other practices to create a flood/debris protection system.

How is a concrete barrier wall installed?

Barrier sections are constructed from reinforced concrete, normally in 10 ft. lengths and weighing 4,000 lbs. or more. They are usually available from precast concrete manufacturers, highway departments or highway contractors. Precast sections are available in many shapes. Because of their size and weight heavy equipment is required to place them.

Concrete Wall Barrier

How is a concrete barrier wall installed?

Selecting Treatment Areas: Use the barriers as a diversion wall to direct debris flows around or away from buildings and other structures. Do not try to dam or stop debris flows. Protect your most valuable property first.

Site Preparation: Prepare the foundation by clearing all vegetation and debris away from the proposed alignment and performing light grading as needed to assure full contact between the base of the barrier sections and the ground.

Placing Barrier Sections: Each section is set end to end along the proposed alignment and drawn or pushed together to form as tight a joint as possible. Sections are connected with a steel rod or pipe slipped through connecting loops cast into the concrete, and driven into the ground at each joint. Four to six inches of soil or sandbags should be placed along the upstream side to block drainage holes and to prevent water from flowing under the barrier.

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Contour Sandbags

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What is a contour sandbags?

Biodegradable bags are filled with on site soil and bedded in a shallow trench forming a continuous barrier along the contour (across the slope) to intercept water running down the slope.

Sandbags are places along the contour of the slope.

When are contour sandbags used?

Contour Sandbags are used on burned slopes that have less than 30% of the original ground cover remaining and are at risk for increased erosion. They can be installed on slopes up to 70 percent; however their effect diminishes greatly on slopes steeper than 50 percent. Soils can be shallow, but not less than about 6 inches. Contour Sandbags increase infiltration, add roughness, reduce erosion, and help retain eroded soil on the slope. Contour Sandbags should be effective for a period up to one year, providing short term protection on slopes where permanent vegetation will be established to provide long term erosion control. Contour Sandbags can accomplish the same treatment as Log Erosion Barriers, but require less skilled labor to install and can be placed on the slope more effectively. Sandbags should not be placed across drainage swales and channels with more than one acre of contributing drainage area because they are not sturdy enough to resist the forces of concentrated flows.

Contour Sandbags

How are contour sandbags installed?

Installation of Contour Sand Bags is straight forward and is an easy practice for untrained laborers, landowners and volunteer groups to complete.

- Layout a contour line on the slope with a hand level and wire flags.
- Dig a shallow depression, about two to three inches deep along the flag line
- Use the soil from the trench excavation to fill bags half to three-quarters full.
- Fold the top over and lay the filled bags end to end in the trench.
- Seat the bags with foot tamped backfill on the upstream side such that water flowing down the slope will not run under them.

What Materials are Needed?

- Sandbags
- Hand tools -shovels, pulaskis

How many sandbags are required?

The horizontal spacing of Contour Sandbags is determined with consideration for normal rainfall intensity, slope steepness, soil characteristics, and the extent of surface cover remaining after the fire. Figures 1 depicts the placement of sandbags on the slope. Table 1 shows recommended spacing for treating burn areas.

Fig. 1 - Typical contour sandbag installation

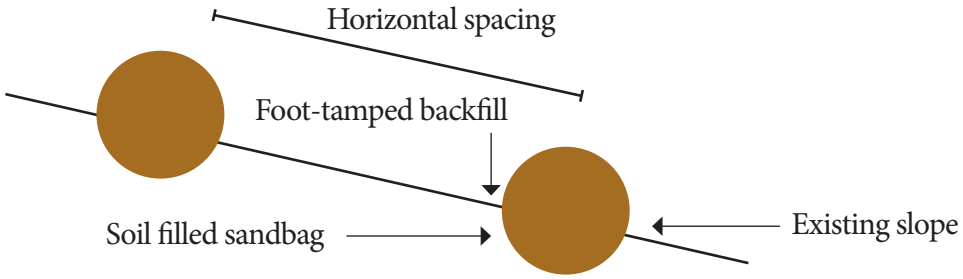

Table 1 - Recommended spacing for contour sandbags

Slope Steepness (percent)	Burn Intensity					
	Low Intensity		Moderate Intensity		Severe Intensity	
	Spacing (feet)	Quantity (bags/ acres)	Spacing (feet)	Quantity (bags/ acres)	Spacing (feet)	Quantity (bags/ acres)
< 5%	250	135	160	204	130	250
5 - 10%	200	164	120	272	90	364
10 - 20%	120	272	60	544	40	818
20 - 50%	60	544	30	1088	20	1634

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after the fire

Erosion Control Mats

CAUTION: After a fire many trees are weakened from burning around the base of the trunk. The trees can fall over or blow down without warning. Shallow-rooted trees can also fall. Therefore be extremely alert when around burned trees.

What are erosion control mats?

An erosion control mat (ECM) is a protective mulch blanket or soil stabilization mat constructed with Rolled Erosion Control Product (RECP). The ECM is anchored on a slope to limit erosion from rainfall or overland flow, or to enhance revegetation. The RECP can be as simple as fiber (jute or coir) or synthetic netting staked down over straw mulch; or as complex as a multi-layer geosynthetic composite blanket.

When are erosion control mats used?

ECMs are used on severely burned slopes that have lost protective vegetative cover. ECMs are expensive so their use is generally limited to small areas to prevent erosion that would otherwise cause significant damage to high value properties. ECMs can be used in conjunction with or as an alternative to mulches. ECMs are not appropriate in all situations.

ECMs are not recommended for steep slopes with sandy soils, or slopes with many rocks on the surface, or for slopes with a significant amount of fire burned vegetation remaining. The ground surface must be fairly smooth, and such obstructions would prevent good contact between the ECM and the soil.

Erosion Control Mats

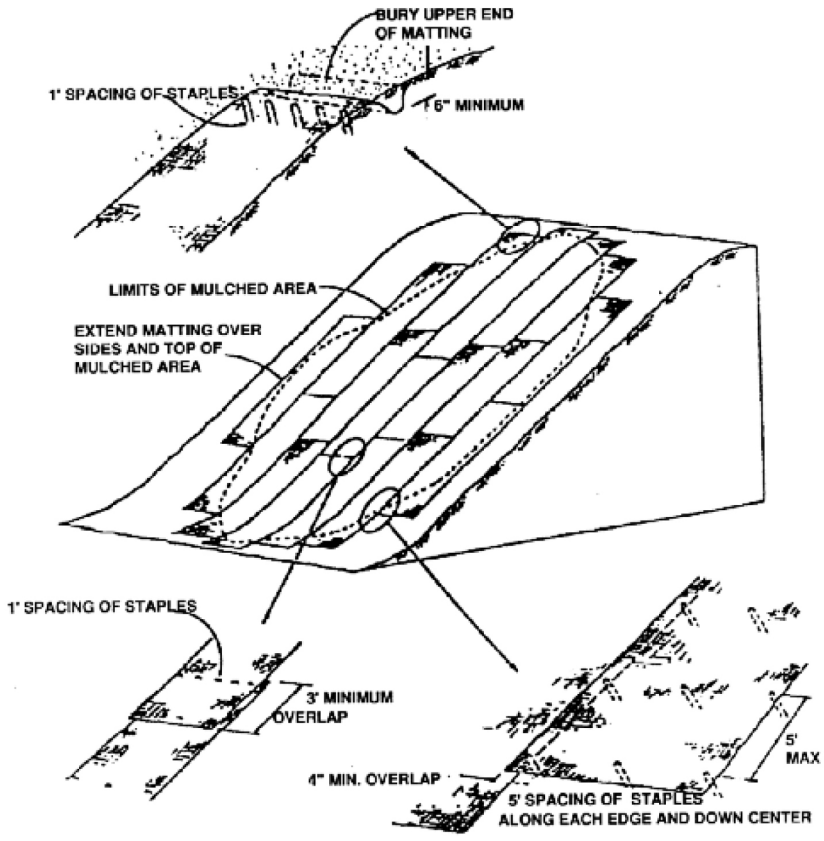
How are erosion control mats installed?

The soil surface should be reasonably smooth. Rocks and other obstructions which rise above the level of the soil and mulch must be removed.

The chosen RECP should be applied up and down the slope - never along the contour. The upper end of the roll at the top of the treated area should be buried in a trench at least 8 inches deep. Rolls should be laid out so that edges overlap each other by at least 6 inches across the slope. When more than one roll is required going down the slope. The ends going down the slope should overlap by at least 3 feet. This is extremely important!

Anchor pins or staples are used to anchor the netting to the soil surface. Anchor pins are made of rigid 0.12 inch diameter or heavier galvanized wire with a minimum length of 10 inches for hook or "J" type pins. Staples should be of wire .09 inches in diameter or greater and should have 'U" shaped legs that are at least 6 inches in length. Longer staples are needed for sandy soils.

Staples or anchor pins need to be driven perpendicularly into the slope face and should be spaced about 5 feet apart down the sides and center of the roll. Spacing between staples at the upper end of a roll, and at the end overlap of two, rolls should not be greater than 1 foot.



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after the fire

Hazard Tree Removal

CAUTION: After a fire many trees are weakened from burning around the base of the trunk. The trees can fall over or blow down without warning. Shallow-rooted trees can also fall. Therefore be extremely alert when around burned trees.

What is hazard tree removal?

The work consists of removing dead and/or damaged trees that pose a hazard to people, animals, personal property, utilities, and other structures that might be damaged from falling trees.

When should trees be removed?

Dead trees that pose a threat to life or property may be located adjacent to homes, outbuildings, access roads and other structures. Assessing tree mortality is an important step in determining the risk to life and property. Refer to University of Idaho Extension's "After the Burn" or WA DNR's "Fire Injured Trees: Making an Initial Assessment of Whether a Tree is Likely to Die" for guidlines in assessing tree mortality.

How should trees be removed?

Work should be completed by qualified fallers and/or equipment operators. Inspect the tree prior to falling to identify any hazards such as cracks, mistletoe brooms or deformities in the bole or canopy that can increase the complexity of falling the tree. When cutting hazard trees, you should try to limit soil disturbance and the number of vehicular trips across your land. This will help to minimize erosion and noxious weed introduction. All branches should be cut from the tree and the trunk of tree should lay flat on the soil surface. Cut-tree material is often more valuable left on-site. Broadcasting chips from dead trees

Hazard Tree Removal

How should trees be removed?

back onto the burned land can help reduce erosion. Log erosion barriers may help stabilize soils on slopes in some areas (see specification on Log Erosion Barriers). In addition, lopping and scattering limbs and finer material can help reduce surface water flow, erosion and improve soil condition by replacing organic matter and nutrients.

Safety precautions

Removing hazardous trees in burned areas is dangerous due to a significant risk that burned trees may fall unexpectedly or drop branches on workers with little or no warning- especially during times of high winds, heavy precipitation and/or saturated soils. Always use the appropriate personal protection gear when operating a chainsaw, such as: hard hat, gloves, eye protection, hearing protection, chaps and steel toed boots. Use chainsaws with spark arresters and review their safety instructions. Review safety instructions when using ATVs or other machinery.

In the years following the fire, many of the trees will begin to fall on their own as roots, trunks and limbs decay. Landowners should continue to be aware of these hazards.

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after the fire

Diversion

CAUTION: After a fire many trees are weakened from burning around the base of the trunk. The trees can fall over or blow down without warning. Shallow-rooted trees can also fall. Therefore be extremely alert when around burned trees.

What is a diversion?

A runoff diversion consists of a channel and dike or ridge constructed across the slope to collect and divert runoff. The earthen channel may remain bare, or when necessary to protect it from erosion it will be lined with vegetation, turf reinforcement mats, or rock. The purpose of this practice is to divert excess surface water from one area for use or safe disposal in other areas.

When is a diversion used?

Diversions are used to divert runoff from burned areas away from values at risk. Diversions may be located:

- Above steep slopes to limit surface runoff onto the slope;
- At the base of slopes where flooding or sediment depositions may occur;
- Around buildings or areas that are subject to damage from runoff.

How is a diversion designed?

Diversions should be designed by an experienced engineer or technician. Important design considerations include:

Capacity. Diversion channels designed to protect areas such as minor buildings and roads shall have enough capacity for the runoff expected from a 25-year frequency, 24-hour duration storm. Diversions designed to protect major structures, homes, school buildings and high capacity roads shall have enough capacity for the 100-year frequency 24-hour duration storm.

Diversion

How is a diversion designed?

Channel Shape. The channel may be parabolic, V-shaped, or trapezoidal in shape. Channel side slopes should be stable and not be steeper than 3:1. A ridge placed on the downstream side of the channel must be high enough to keep the runoff in the channel without overtopping. The ridge height should provide at least 6 inches of freeboard and have a top width of 4 feet or more.

Channel Slope. Runoff Diversion channels must be graded to prevent water standing and a design velocities greater than 1.5 feet per second to avoid sediment accumulation. Channels with design velocities greater than 2.5 feet per second will require some type of lining. Used the following as a guide:

Outlets. Diversion channels must be able to deliver the runoff to a stable outlet, at a point where outflow will not cause damage. Some type of outlet structure or special lining over the outlet section of the diversion channel may be required.

Max. velocity (feet per second)	Channel slope (percent)	Recommended lining material
< 2.5	< 0.5%	Earth
2.5 - 4.5	< 2%	Vegetation, Mulched & Netted or Crimped Vegetation with Temporary TRM Earth & Permanent TRM
> 4.5	< 10%	Rock Vegetation with Permanent TRM
> 4.5	> 10%	Rock or concrete Permanent TRM

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What maintenance is required?

Runoff diversions should be inspected after every major rainfall. Any needed repairs to the channel, lining or dike must be made promptly to maintain diversion capacity, ridge height, lining integrity, and outlet stability.

Typical Runoff Diversion Cross Section