NRCS
Natural Resources
Conservation Service

Contour Sandbags

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NOTE

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 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.

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 1 acre of contributing drainage area because they are not sturdy enough to resist the forces of concentrated flows.

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 2 to 3 inches deep along the flag line
- Use the soil from the trench excavation to fill bags ½ to ¾ 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 1A and 1B show recommended spacing for treating burn areas along the front range in Colorado.

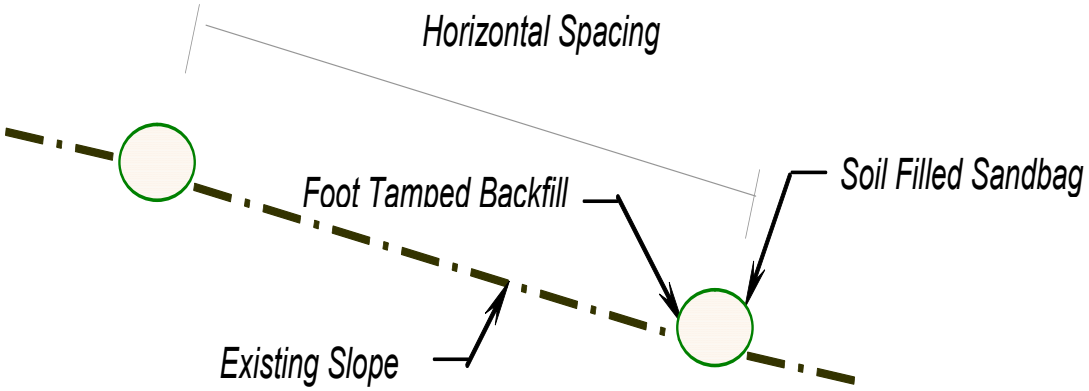

FIGURE 1 - Typical contour sandbag instillation

Burn Severity Land slope (percent)	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
> 50%	40	818	20	1634	20	1634

TABLE 1 - Recommended spacing for contour sandbags

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Contour Wattles

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What are contour wattles?

Straw Wattles, also known as fiber rolls, bio-logs, or straw tubes are man made cylinders of compressed, weed free straw (wheat or rice), 8 to 12 inches in diameter and 20 to 25 feet long. They may also be filled with other types of weed free fibers. They are encased in jute, nylon, or other photo degradable materials, and have an average weight of 35 pounds. They are installed in a shallow trench forming a continuous barrier along the contour (across the slope) to intercept water running down a slope.

When are contour wattles used?

Straw Wattles 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 50 percent. Soils can be shallow, but not less than about 8 inches. Straw Wattles increase infiltration, add roughness, reduce erosion, and help retain eroded soil on the slope. Straw Wattles should be effective for a period of one to two years, providing short term protection on slopes where permanent vegetation will be established to provide long term erosion control. Contour Straw Wattles accomplish the same treatment as Log Terraces, but require less skilled labor to install and can be placed on the slope more effectively. Straw wattles should not be placed across drainage swales and channels with more than 2 acres of contributing drainage area because they are not sturdy enough to resist the forces of concentrated flows.

What materials are needed?

- 9 -12 inch diameter tubes, 10-30 feet long.
- 5 - 1x2 or 2x2 wooden stakes, 18 - 24 inches long per wattle.
- Hand tools -shovels, polaskis, & stake hammer.
- Small machines for plowing trenches on 30% or flatter slopes.

How are contour wattles installed?

- Layout a contour line on the slope with a hand level and wire flags.
- Dig a shallow depression (about 3 to 5 inches deep) and lay the wattle into it.
- Drive a 1x2 or 2x2 wooden stake through the center of the wattle at least 6 inches into the ground, stopping about two inches above the wattle.
- Put 5 stakes in each wattle, installing them end to end in the trench.
- Seat the wattle with foot tamped backfill on the upstream side such that water flowing down the slope will not run under it.

How many wattles are required?

The horizontal spacing of wattles on the slope is based on normal rainfall intensity, slope steepness, soil characteristics, and the extent of surface cover remaining after the fire. Figure 1 depicts the placement straw wattles on the slope. Table 1 shows recommended wattle spacing.

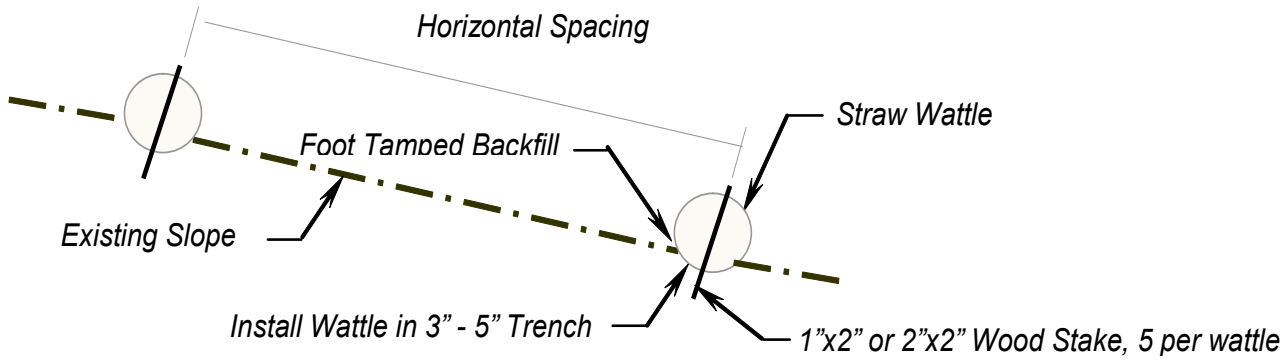

FIGURE 1 - Typical straw wattle installation

Burn severity	Low Intensity		Moderate Intensity		Severe Intensity	
land slope (percent)	Spacing (feet)	# Wattles (feet/acre)	Spacing (feet)	#Wattles (feet/acre)	Spacing (feet)	#Wattle (feet/acres)
5 - 10%	200	218	120	363	90	484
10 - 20%	120	363	60	726	40	1089
20 - 50%	60	726	30	1452	20	2178
> 50%	40	1089	20	2178	20	2178

TABLE 1 - Recommended spacing for contour wattles

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Erosion Control Mats (ECM)

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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.

An erosion control specialist should be consulted to determine the best type of RECP needed at a specific site.

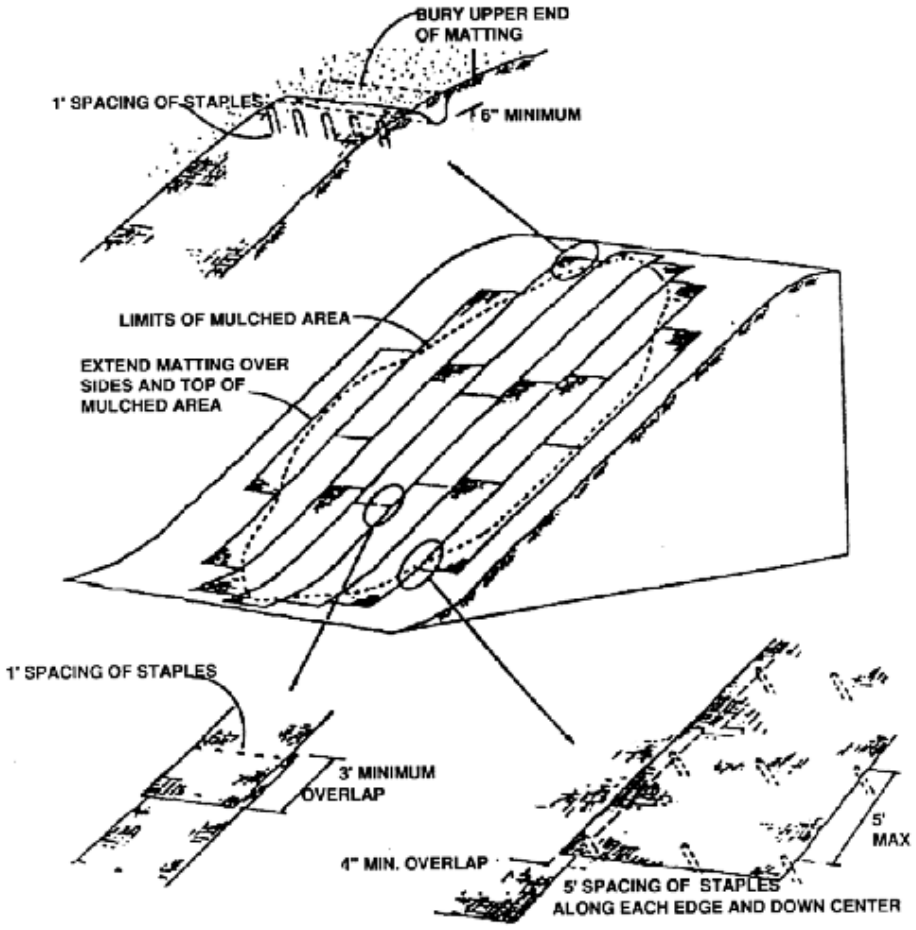
How are erosion control mats installed?

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.


BURY UPPER END OF MATTING
1" SPACING OF STAPLES
6" MINIMUM
LIMITS OF MULCHED AREA
EXTEND MATTING OVER SIDES AND TOP OF MULCHED AREA
1" SPACING OF STAPLES
3" MINIMUM OVERLAP
4" MIN. OVERLAP
5' MAX
5' SPACING OF STAPLES ALONG EACH EDGE AND DOWN CENTER

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Hand Raking
(light scarification)

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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%.

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 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. Hand raking is not used in swales, drainage ways, gullies, or other areas of concentrated flow.

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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 spacimg (feet)
< 5%	160
5 - 10%	120
10 - 20%	60
20 - 30%	30

NOTE: 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. Shalow rooted trees can also fall. Therefore be extremely alert when around burned trees.

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Log Erosion Barriers (LEBs)

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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% to 60%, 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, adds 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.

What materials are 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% or flatter slopes

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.

How many log erosion barriers 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.

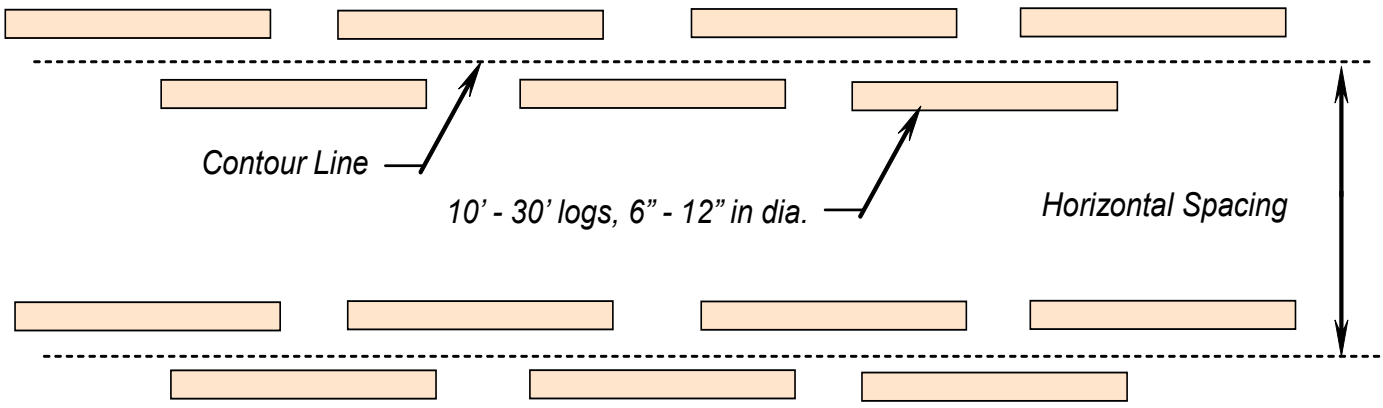

FIGURE 1 - Theoretical log terracing pattern

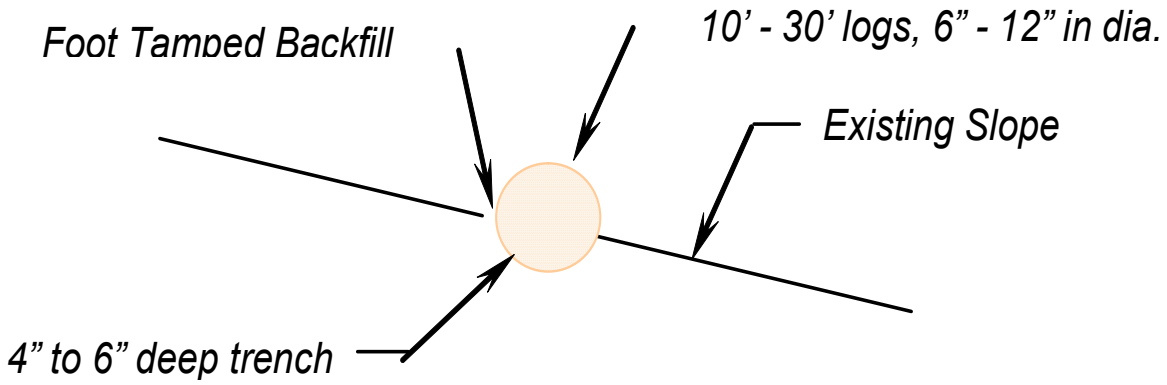

FIGURE 1 - Typical log & bedding detail

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

TABLE - Recommended spacing for contour slope treatments

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Mechanical Scarification

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What is mechanical scarification?

Mechanical scarification is the tilling or ripping of the soil across the slope using farming or construction equipment. The purposes of this treatment is to loosen and mix the soil profile in order to create a better seedbed, improve infiltration, and where present, reduce any hydrophobic characteristics that may have developed as a result of the fire.

When is mechanical scarification used?

Mechanical scarification is used primarily on burned slopes of less than 30% where soils are compacted or exhibit significant hydrophobic properties.

Scarification is useful to improve conditions for seeding and mulching. Scarification can improve infiltration if the soil is deep and permeable enough that precipitation can percolate through it once it moves below the soil surface (NRCS Hydrologic Group A & B soils).

Scarification by itself is not an effective erosion control practice and can increase erosion when rainfall intensity exceeds the infiltration rate, as the loose soil is eroded more easily by runoff. Therefore scarification should be combined with other erosion control practices such as mulching. Mechanical Scarification should not be used in swales, drainage ways, gullies, or other areas of concentrated flow.

How is mechanical scarification performed?

Tractors, bulldozers or similar equipment either pull a tillage implement or are fitted with a tool bar containing tines, rippers or other devices capable of loosening and mixing the soil to a depth of at least 6 inches.

A contour line is marked about 1/3 the way down the slope to establish a key line. The machines are operated parallel to the key line. Scarification must not be performed up and down the slope. The entire slope may be scarified to accomplish the maximum effect. To reduce treatment costs mechanical scarification can be limited to 8 to 12 foot wide strips spaced uniformly over the slope. The maximum recommended spacing between scarified strips is shown below:

Slope Gradient (percent)	Contour Strip Spacing (feet)
< 5%	160
5 - 10%	120
10 - 20%	60
20 - 30%	30
> 30%	not recommended

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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 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.

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 seed should have adequate soil to support vegetation. Seeding slopes steeper than 60% is difficult, and not especially effective for reestablishing permanent vegetation.

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.

When is the right time to seed after a fire??

Grasses and forbs should be planted after the wildfire when the soil surface is loose. Seeding in late fall or winter (even if there are a few inches of snow) improves success. 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.

Who 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% 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 hydro mulching operation should be considered when revegetation is essential to protecting high value properties immediately downstream of the area being treated.

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.

Annual ryegrass and 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.

You should use certified seed of a known variety to get the best results. If a specified variety is not available, be sure the seed originated within a 500-mile radius of your property. Be sure seed does not contain any noxious weeds.

Most seeding recommendations are expressed in terms of pounds of pure live seed (PLS) per acre. Double recommended seeding rates on severely burned areas or steep slopes.

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. Hydro mulching 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. (additional O&M suggestions?).

Grass/Forb Species	Native (N) or Introduced (I)	Pounds PLS per acre (40 seeds per sq. ft.)

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Straw Bale Check Dam

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What is a straw bale check dam?

These are temporary sediment barriers constructed of straw bales across very small drainages

When is a straw bale check dam used?

These temporary structures are used to slow debris flow. They are not intended to provide protection from large storm events nor to control debris flows in water bodies such as creeks, streams and rivers. Straw Bale Check Dam design limits are as follows:

Slope	Maximum drainage area between check dams	Maximum Slope Length
0 - 15 %	1 acre	200 feet
15 - 20 %	1/2 acres	100 feet
> 20 %	Not Recommended	

How are straw bale check dams installed?

Bales should be bound with wire or nylon string. Twine bound bales are less durable. The bales should be placed in rows with bale ends tightly abutting the adjacent bales.

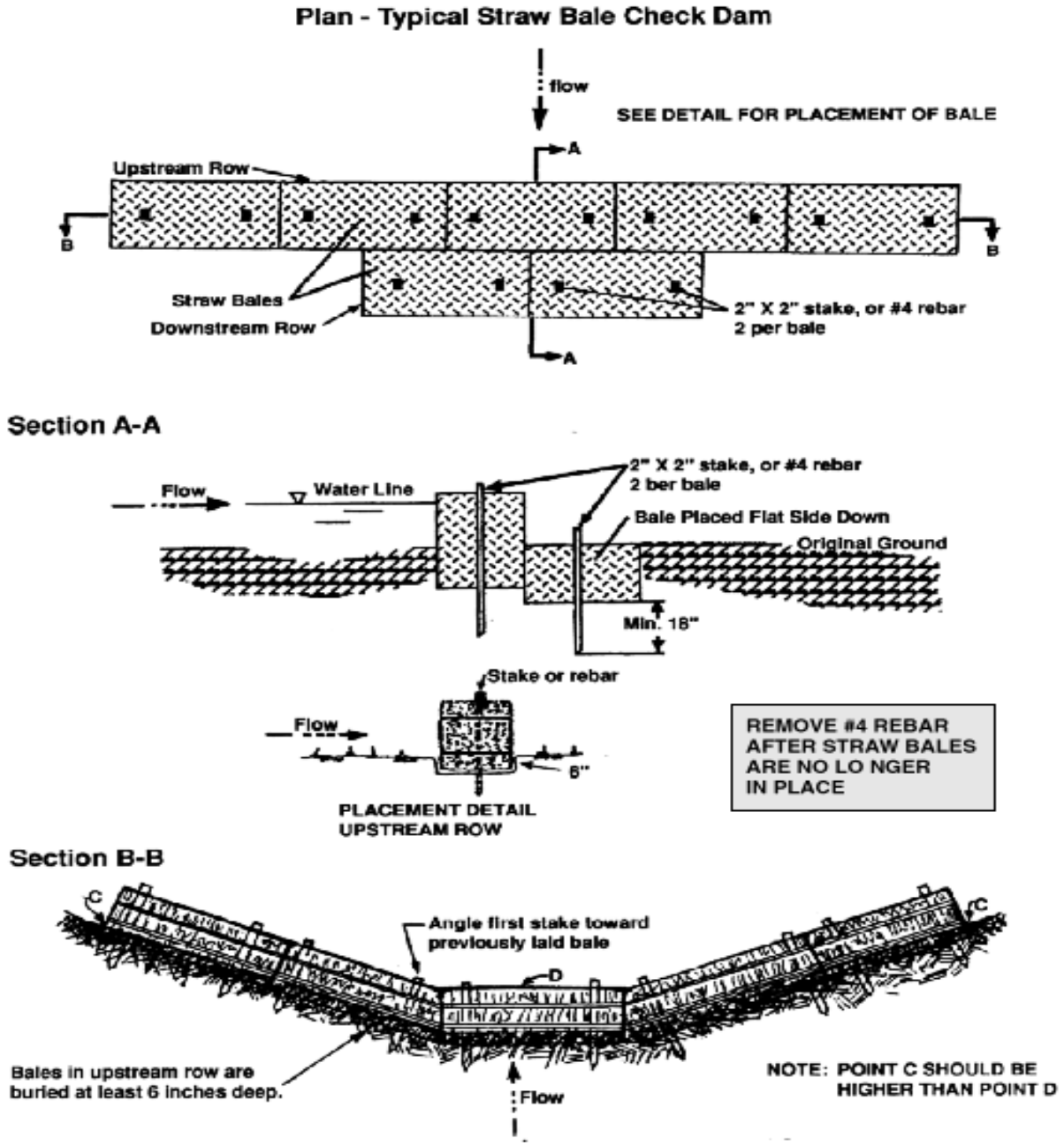
Downstream Row (refer to illustration): Dig a trench across the small channel, wide enough and deep enough to so that the top of the row of bales placed on their long, wide side is level with the ground. The tops of bales across the center of the channel should all be level and set at the same elevation. Place the bales in position and stake them according to the instructions below.

Upstream Row: Dig another trench across the small channel, upstream and immediately adjacent to the first row of bales. The trench should be wide enough to accommodate a row of bales set vertically on their long edge. The trench should be deep enough so that at least 6 inches of each bale is below ground starting with the bale in the channel bottom. The trench should be as level as possible so that the tops of the bales across the center of the channel are level and water can flow evenly across them. Continue this trench up the side slopes of the small channel to a point where the unburied bottom line of the highest bale (point "C", illustration) is higher than the top of the bales that are in the center of the channel (point "D", illustration).

Anchorage: Drive 2 x 2 stakes or #4 rebar through the bales and into the ground 1 1/2 to 2 feet for anchorage. The first stake in each bale should be driven toward a previously laid bale to force the bales together (see illustration).

What maintenance is needed?

Inspect the bale check dam and provide necessary maintenance following each storm period. Remove the bales and stakes once permanent drainage and stabilization is re-established. Used straw can be used as mulch in other areas.



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Straw Bale Dike

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What is a straw bale dike?

A temporary sediment barrier constructed of straw bales located down slope of a disturbed area or around a storm drainage outlet to redirect debris flows or trap debris materials.

When is a straw bale dike used?

Usually installed in areas requiring protection from sedimentation expected from predicted rainfall events that will cause erosion and are intended to provide protection for a limited time period (less than 3 months).

How is the straw bale dike installed?

Straw Bale Dikes drainage area limits are as follows:

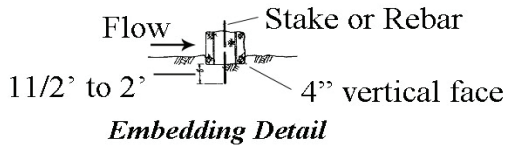
Slope	Maximum Drainage Area	Maximum Slope Length
0 - 15 percent	1 acre	200 feet
> 15	1/2 acre	100 feet

Methods and Materials: Bales should be bound with wire or nylon twine. Twine bound bales are less durable. Bales should be placed in a row with ends tightly abutting the adjacent bales. Do not place bales with wire or twine touching the soil (see illustration). Some loose straw should be compressed between adjacent bales to close voids. The tops of bales should all be level and set at the same elevation.

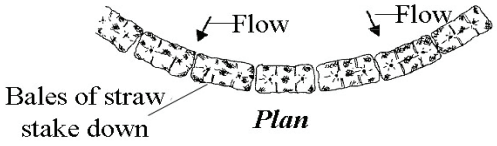
Anchorage: Each bale should be embedded in the soil a minimum of 4 inches. Drive 2x2 stakes or rebar through the bales and into the ground 1 1/2 to 2 feet for anchorage. The first stake in each bale should be driven toward a previously laid bale to force the bales together. Please refer to the drawings on the back side of this sheet

What maintenance is required?

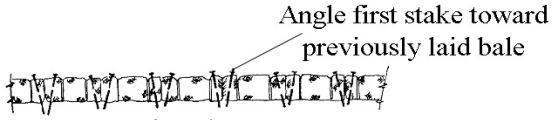
Inspect the bale dike and provide necessary maintenance following each storm period. It is important to assure that loose straw does not enter storm drain facilities. Remove the bales once permanent drainage and stabilization is reestablished. Used straw can be used as mulch in other areas.



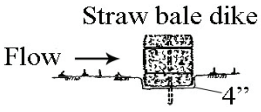
Embedding Detail



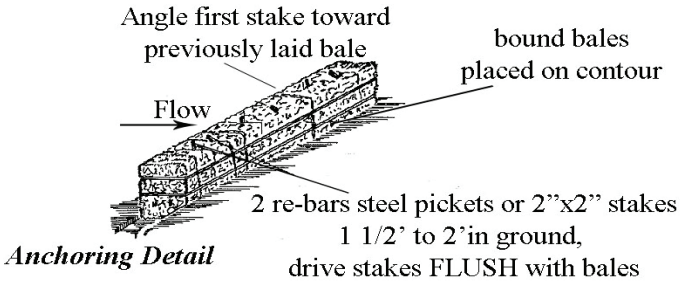
Plan



Elevation



Bedding Detail



Anchoring Detail

NOTE: 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.